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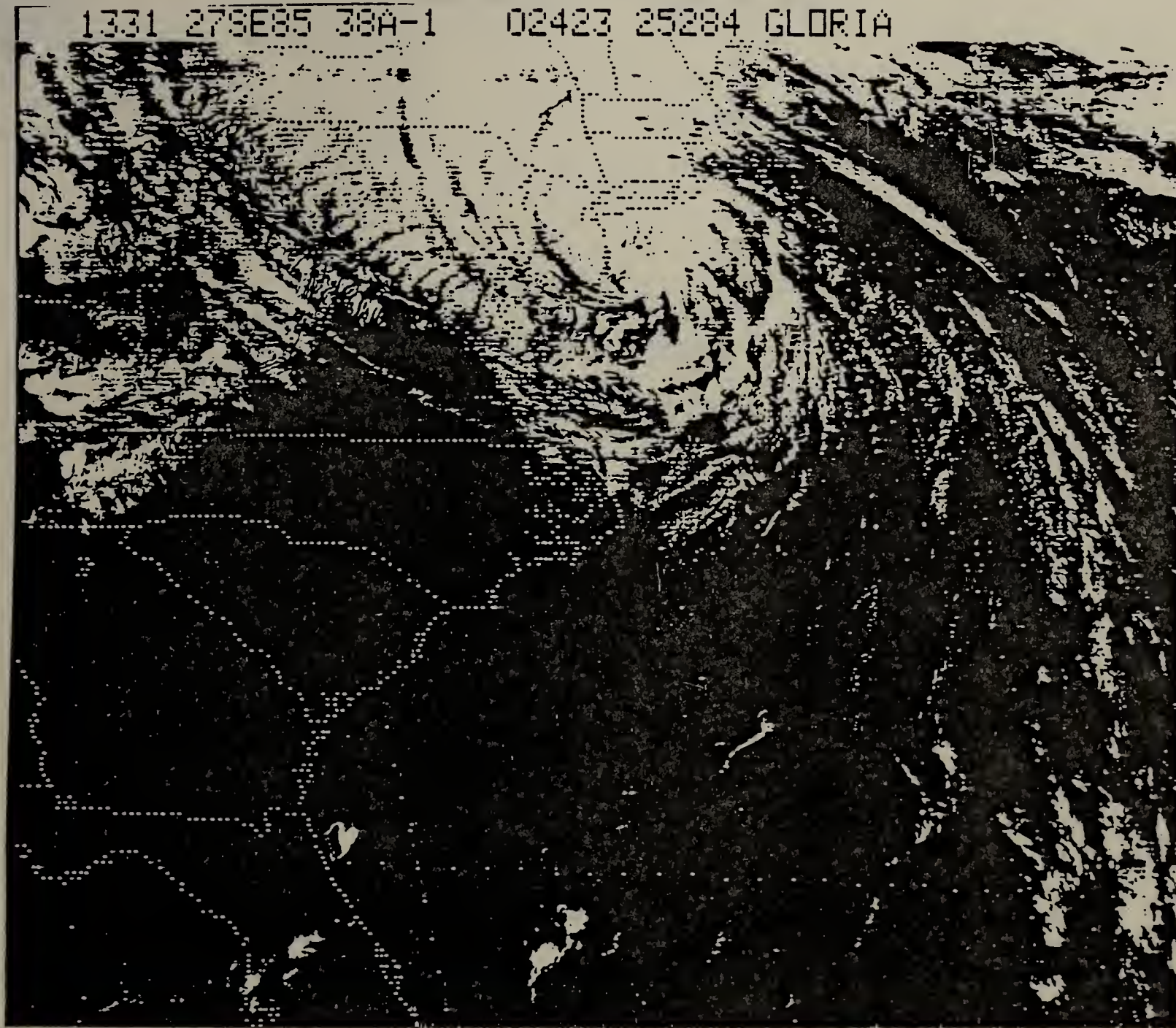


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Commonwealth of Massachusetts

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Section 406

HAZARD MITIGATION PLAN

1986

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THE COMMONWEALTH OF MASSACHUSETTS

EXECUTIVE DEPARTMENT

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MICHAEL S. DUKAKIS
GOVERNOR

February 9, 1987

Mr. Henry G. Vickers
Regional Director
Federal Emergency Management Agency
Region I
J.W. McCormack Post Office and Court House
Boston, MA. 02109

Dear Mr. Vickers:

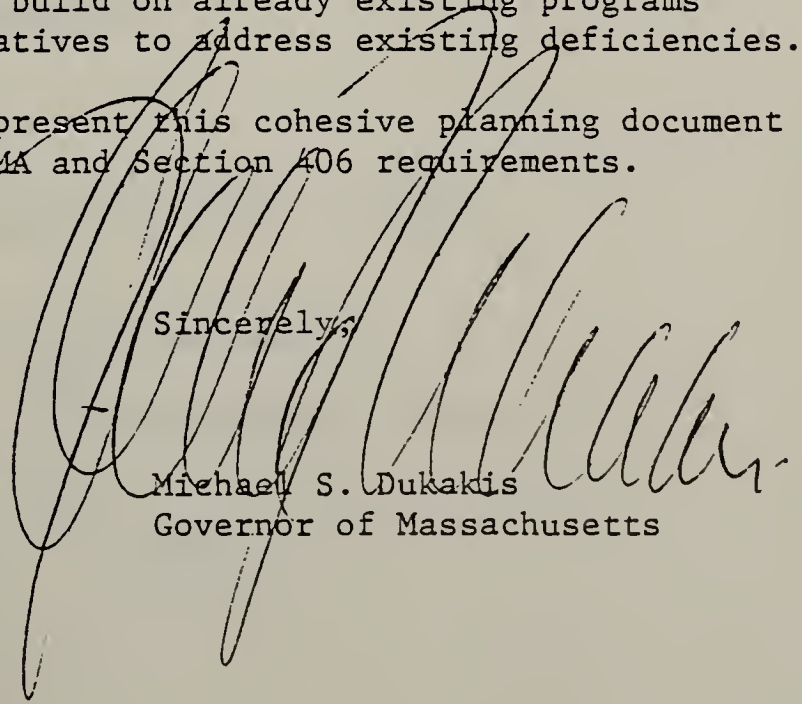
The Commonwealth of Massachusetts has completed its Hazard Mitigation Plan. The plan has been prepared in accordance with the Federal Disaster Relief Act of 1974, Section 406 of Public Law 93-288. Gloria was identified as Major Disaster No. FEMA-751 DP.

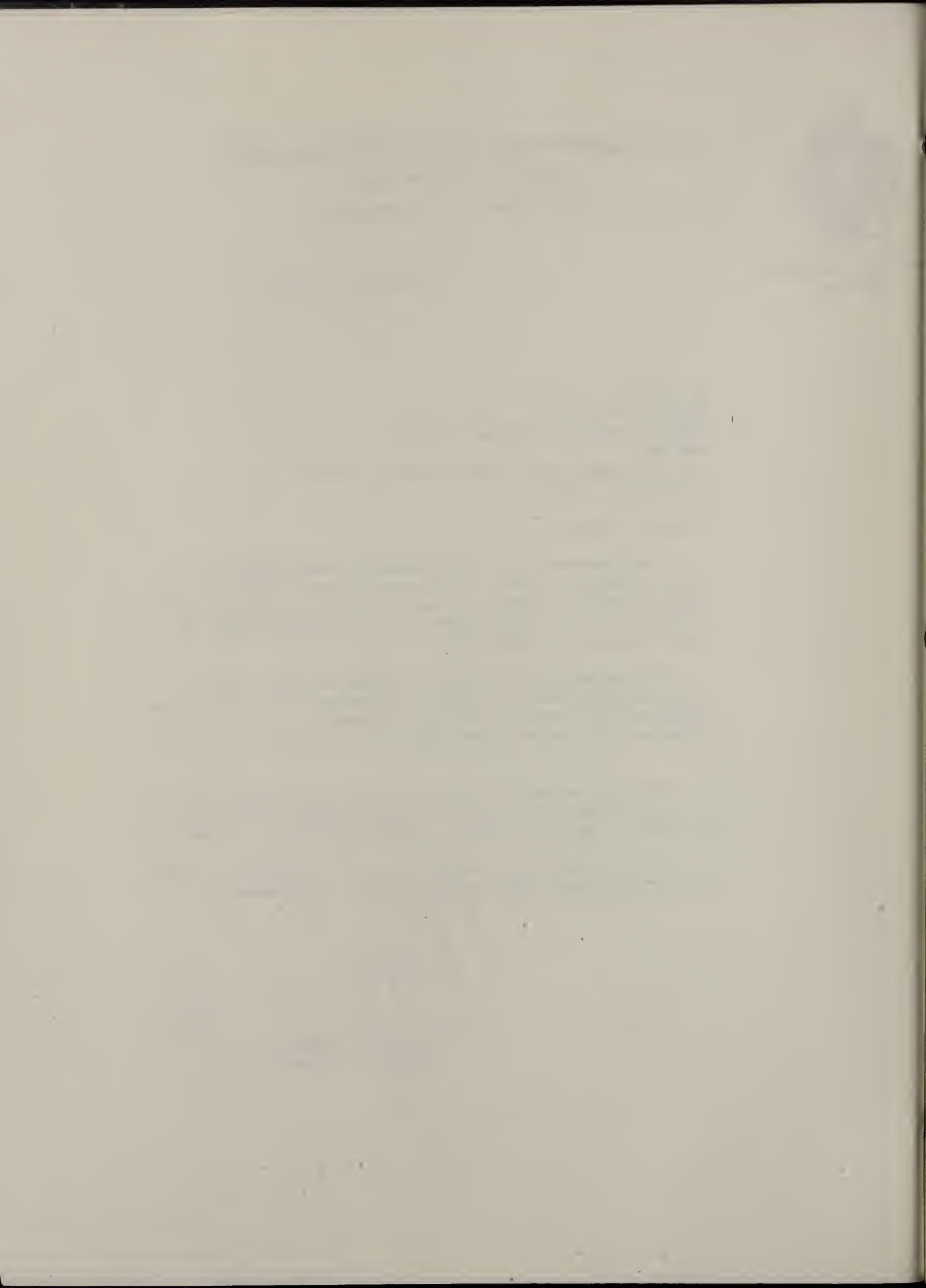
The hazard mitigation plan reviews current federal, state and local hazard mitigation programs. These programs compliment one another providing a diversity of protective measures which reduce flood losses and hardships to a minimum.

The recommendations section of the plan present hazard mitigation steps that build on already existing programs and develop new initiatives to address existing deficiencies.

I am pleased to present this cohesive planning document which will satisfy FEMA and Section 406 requirements.

Sincerely,


Michael S. Dukakis
Governor of Massachusetts



MASSACHUSETTS

Section 406

HAZARD MITIGATION PLAN

Prepared by

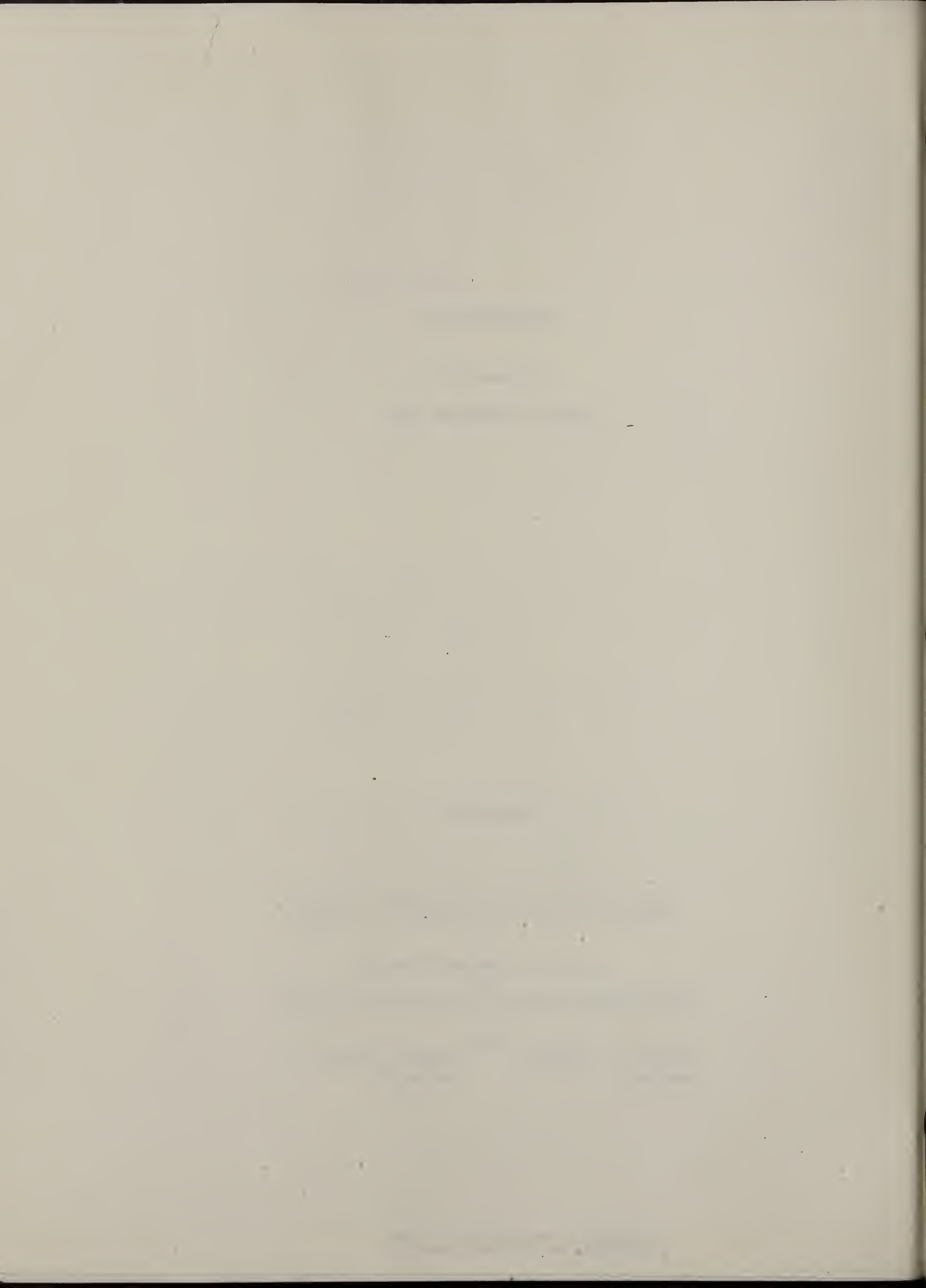
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS

Division of Water Resources
and
Massachusetts Coastal Zone Management Office

1987

Michael S. Dukakis
Governor

James S. Hoyte
Secretary



ACKNOWLEDGEMENTS

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Henry Vickers	Federal Emergency Management Agency
Jim Wesolosky	U.S. Soil Conservation Services
Vicki Zaloawa	Farmers Home Administration

Special appreciation is extended to the many agencies who responded to the Hazard Mitigation Questionnaire.

TABLE OF CONTENTS

	<u>PAGE</u>
ACKNOWLEDGEMENTS	ii
LIST OF FIGURES	vi
LIST OF TABLES	vii
CHAPTER I	1
Introduction	
Authority	
Purpose	
Scope	
CHAPTER II	4
Background	
Description of Event	
Cost of Disaster	
Description of Previous Events	
CHAPTER III	17
Problem Identification	
Extent of Damage	
Cause of Damage	
Additional Hazard Identification	
CHAPTER IV	23
Inventory of Existing Mitigation Measures	
Principal State Program Activities	
Principal Regional Program Activities	
Principal Local Program Activities	
Principal Private Program Activities	
Principal Federal Program Activities	

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TABLE OF CONTENTS

	<u>PAGE</u>
ACKNOWLEDGEMENTS	ii
LIST OF FIGURES	vi
LIST OF TABLES	vii
CHAPTER I	1
Introduction	
Authority	
Purpose	
Scope	
CHAPTER II	4
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Description of Previous Events	
CHAPTER III	17
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Cause of Damage	
Additional Hazard Identification	
CHAPTER IV	23
Inventory of Existing Mitigation Measures	
Principal State Program Activities	
Principal Regional Program Activities	
Principal Local Program Activities	
Principal Private Program Activities	
Principal Federal Program Activities	

TABLE OF CONTENTS

	<u>PAGE</u>
CHAPTER V	70
Relationship Between Existing Measures and Damages	
CHAPTER VI	77
Implementation Measures	
APPENDICES	81

LIST OF FIGURES

	<u>PAGE</u>
1. Historic Hurricane Tracks.	6
2. Complete Track of Hurricane Gloria, September 22-27, 1985.	8
3. Rainfall Distribution - Hurricane Gloria, September 27, 1985.	10
4. Wind Speeds - Hurricane Gloria, September 27, 1985.	11

LIST OF TABLES

	<u>PAGE</u>
1. Cost Sharing For Eligible Damages.	12
2. Damage Reimbursement Catagories.	13
3. Agriculture Service Buildings Damaged.	14
4. Natural Disasters In Massachusetts (FEMA,DMIS Report 02/26/86).	16
5. Agricultural Production Losses: Bristol, Middlesex and Worcester Counties.	18
6. Hazard Identification Capability Assessment and Multi-Year Development Plan For Local Governments.	20
7. Local Capability For Implementing Hazard Analysis and Mitigation.	22
8. Summary Of Selected State and Local Program Activities In Floodplain Management.	25
9. Principal State Program Activities in Floodplain Management (From ASFPM).	26
10. Key Elements In State Floodplain Management Programs.	27
11. Status Of Community Participation In The NFIP.	40
12. Selected Community Review.	71
13. Qestionnaire Results.	74

CHAPTER I

INTRODUCTION

AUTHORITY

This hazard mitigation plan has been prepared by the Commonwealth of Massachusetts, Executive Office of Environmental Affairs through the cooperative efforts of the Department of Environmental Management, Division of Water Resources and the Massachusetts Coastal Zone Management Office pursuant to:

Public Law 93-288 (Section 406), as amended;

Federal-State Disaster Agreement dated
October 29, 1985 for FEMA Disaster No.
FEMA-751-DR-MA

PURPOSE

On October 28, 1985 the President determined that damages resulting from high winds, storm surge and flooding as a result of Hurricane Gloria on September 27, 1985, caused a major disaster in Massachusetts. A Federal-State Disaster Agreement was entered into on October 29, 1985 between the Commonwealth of Massachusetts and FEMA providing for Public Assistance to the Commonwealth. In return for Federal Assistance the Commonwealth agreed, in part, to ... "evaluate the natural hazards...".

The preparation of this document fulfills the legal obligations of the Federal-State Agreement and further, identifies measures that will minimize and/or eliminate flood hazards through the implementation of long and short term recommendations. This hazard mitigation plan is intended to provide Federal, State and Local governments as well as the general public with proper hazard mitigation strategies.

SCOPE

This hazard mitigation plan is a systematic identification of policies, programs, strategies and actions to be carried out by Massachusetts and its 351 communities to use the legal authorities, financial capabilities and political leadership available to reduce or avoid long term vulnerability to hazards. The plan attempts to include all the feasible and cost-effective measures available to limit hazard vulnerability. To meet the requirements of Section 406, this plan includes the following major elements:

- (1) evaluation of Hurricane Gloria and other natural hazards in Massachusetts. This hazard evaluation includes:
 - (a) descriptive information concerning the nature, severity and extent of GLORIA, as well as the frequency and historical occurrence of natural hazard events that are expected to cause damage and loss to people and property.
 - (b) an analysis of hazard vulnerability trends and changes in vulnerability that can be expected to occur through time under current conditions of planning and hazard management. This analysis incorporates hazard analysis or hazard identification performed as part of a FEMA funded Hazard Identification/Capability Assessment/Multi-Year Development Plan (HICA MYDP).
- (2) description of current State/local hazard management policies/programs/capabilities. Many official policies or programs of State or local government influence development in hazard prone areas and contribute to either increasing or

decreasing vulnerability to hazards. This analysis summarizes the following:

- (a) land use planning and zoning practices;
- (b) state and local environmental codes;
- (c) wetland and floodplain protection practices;
- (d) construction codes and building requirements;
- (e) hazard awareness and public information/education programs;
- (f) public works programs for hazard control and damage prevention.

- (3) proposed hazard mitigation strategies, programs, and recommendations. Based upon the problems of hazard vulnerability defined in the hazard evaluation and the review of current programs, policies and capabilities for managing hazards, the plan proposes a specific set of actions or measures for addressing each of the major current areas of need in Massachusetts hazard management programs. For each of the functions or activities identified in (2)(a-f) above, the plan includes proposed improvements, modifications or changes which would help to reduce or avoid vulnerability to hazards identified in (1) above. For each proposed new hazard mitigation strategy, program or action, the plan includes an identification of:

- (a) anticipated completion dates or implementation schedules;
- (b) the department, agency or official of State or local government responsible for implementation;
- (c) anticipated costs of carrying out the recommendation;
- (d) the proposed source of funding.

CHAPTER II

BACKGROUND

DESCRIPTION OF EVENT

As hurricane Gloria developed off the coast of Africa it was reported as possibly becoming one of the worst hurricanes to hit the eastern seaboard during this century. The hurricane of 1938 has long been considered the most devastating to hit Massachusetts. The likelihood of Gloria equalling, if not surpassing, the 1938 hurricane was reported as great.

Gloria's potential threat was evident by the warnings issued by the National Weather Service (NWS) on Thursday September 26, 1985 at 6:46 A.M. Eastern Daylight Time.

Because of the uncertainty of the forecast track and strength of Gloria, it is imperative that Massachusetts residents keep very close tabs on the progress of this dangerous hurricane. If the hurricane turns north earlier than expected and begins to increase its forward speed, a dangerous situation could develop rapidly. The N.W.S. cannot emphasize enough the importance of monitoring local statements from the weather service office in Boston, and the advisories raised by the National Hurricane center in Miami, FLA.

Gloria was initially classified as a tropical depression (a tropical cyclone in which the maximum sustained wind is 38 mph or less) with sustained winds of 35 mph just west of the Cape Verde Islands about 1,000 miles west of Africa. The storm moved westward while steadily increasing its sustained wind speed. On September 22nd the storm was classified as a

full hurricane (a tropical cyclone in which the maximum sustained wind is 74 mph or more) with sustained winds of 75 mph when it reached a point 400 miles east of Puerto Rico.

Two days later on September 24, 1985 Gloria had achieved sustained winds of 125 mph and progressed northwestward to a point east of the Bahama Islands. At this point the storm had created a great deal of concern on the part of meteorologists because of the system's similarities to the devastating 1938 hurricane. The most devastating hurricanes to hit Massachusetts have originated in roughly the same location as Gloria (Figure 1). As these systems build they have thousands of miles to travel westward over warm water with no landmass obstructions. Gloria took full advantage of these conditions covering an immense area and building into a Class 5 hurricane (winds greater than 155 miles per hour) which is the highest rating on the Saffir/Simpson scale (Appendice A).

On Wednesday September 25th the recorded depression of the system was 27.11 inches, the lowest on record for the greater east coast area. Clearly there was good cause for the following steps to be taken as reported by the National Weather Service at 7:30 a.m. Friday September 27, 1985.

Hurricane Gloria is a very serious threat to Massachusetts. The Massachusetts Civil Defense Agency has ordered evacuation of low lying areas and vulnerable coastal areas in the following Massachusetts counties; Barnstable, Bristol, Plymouth, Suffolk, Middlesex, Essex, and, Norfolk. Civil Defense shelters and armories are now open to shelter evacuees. In addition, all public schools in Massachusetts are closed. All nonessential state and federal offices are closed and all non-essential state employees should remain at home. Persons in Duke's and Nantucket counties should be prepared to move to higher ground away from the coast.

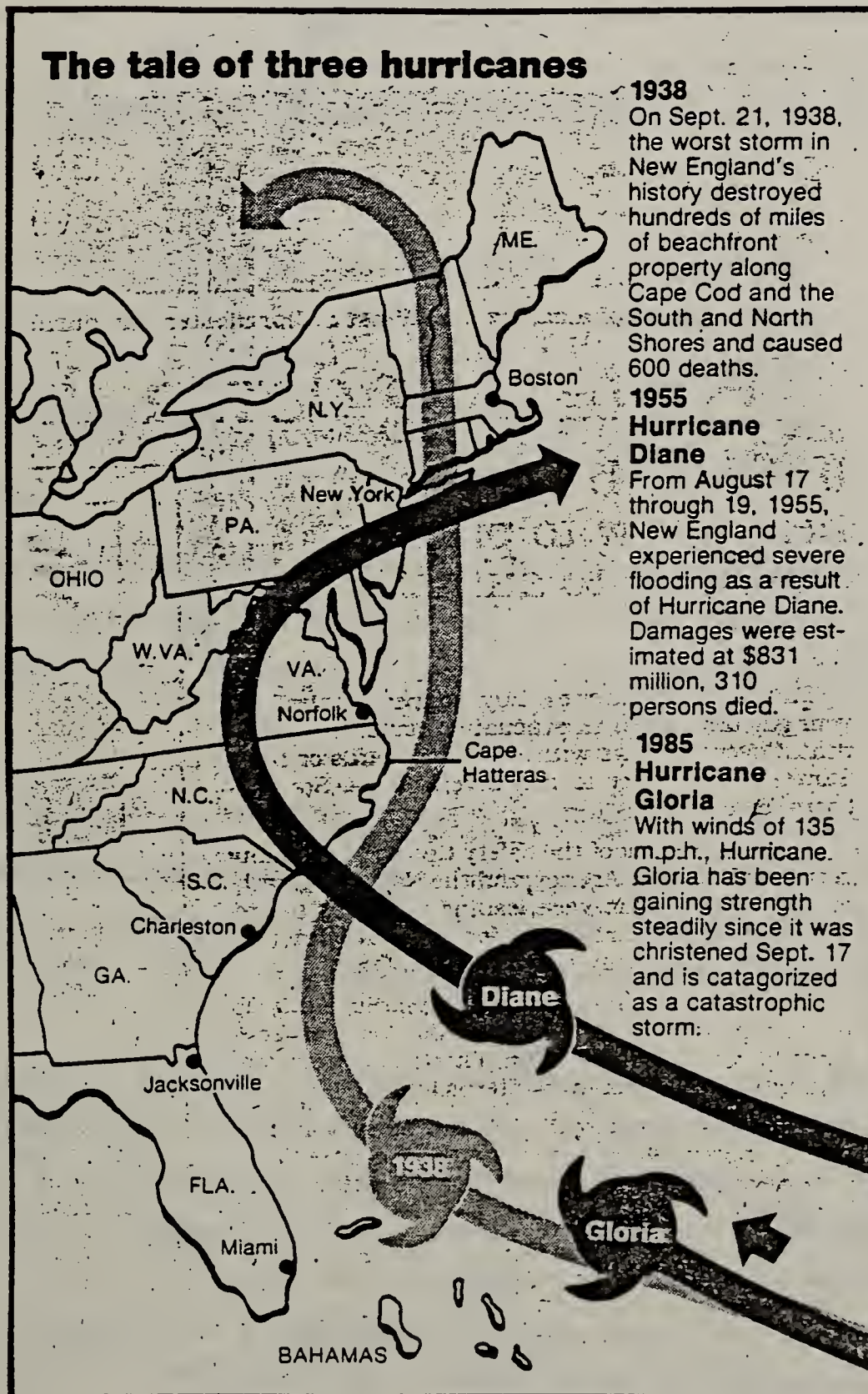


Figure 1. Historic hurricane tracks.

On September 25th the storm's sustained winds reached 150 mph with gusts up to 172 mph. This would be Gloria's highest sustained winds. The storm progressed northwestward toward Charleston, South Carolina and then made a marked turn north toward Cape Hatteras (Figure 2) arriving there at 2:00 a.m. EDT as the following National Weather Service announcement indicates.

"The center of Gloria is over the Cape Hatteras area of North Carolina. At 2 AM EDT...Gloria was centered near Lat. 35.3 North, Long. 75.6 West. Gloria is moving at 20 to 25 mph and is expected to be near the New Jersey coast by mid day and over New England late today."

At this point there was a fear that Gloria might return to sea, rebuild its strength and move back into the mainland at Long Island, Rhode Island or Massachusetts bringing with it renewed strength. Such a pattern would be similar to that of the 1938 hurricane.

Since the storm was clearly a threat to most of the Eastern Seaboard, weather forecasters issued hurricane warnings from the Carolina's north to Plymouth, Massachusetts. The states of Carolina, Virginia, New Jersey and Rhode Island declared states of emergency.

When the storm passed near the vicinity of New York it did so during low tide. This significantly reduced the effects of tidal surge. If the storm travelled through this coastal area at high tide the flooding damages could have been devastating. A seven to nine foot above average tide was reportedly possible. Such a storm surge would have had severe consequences for low lying areas. Fortunately Gloria started to lose strength just after the storm passed Long Island.

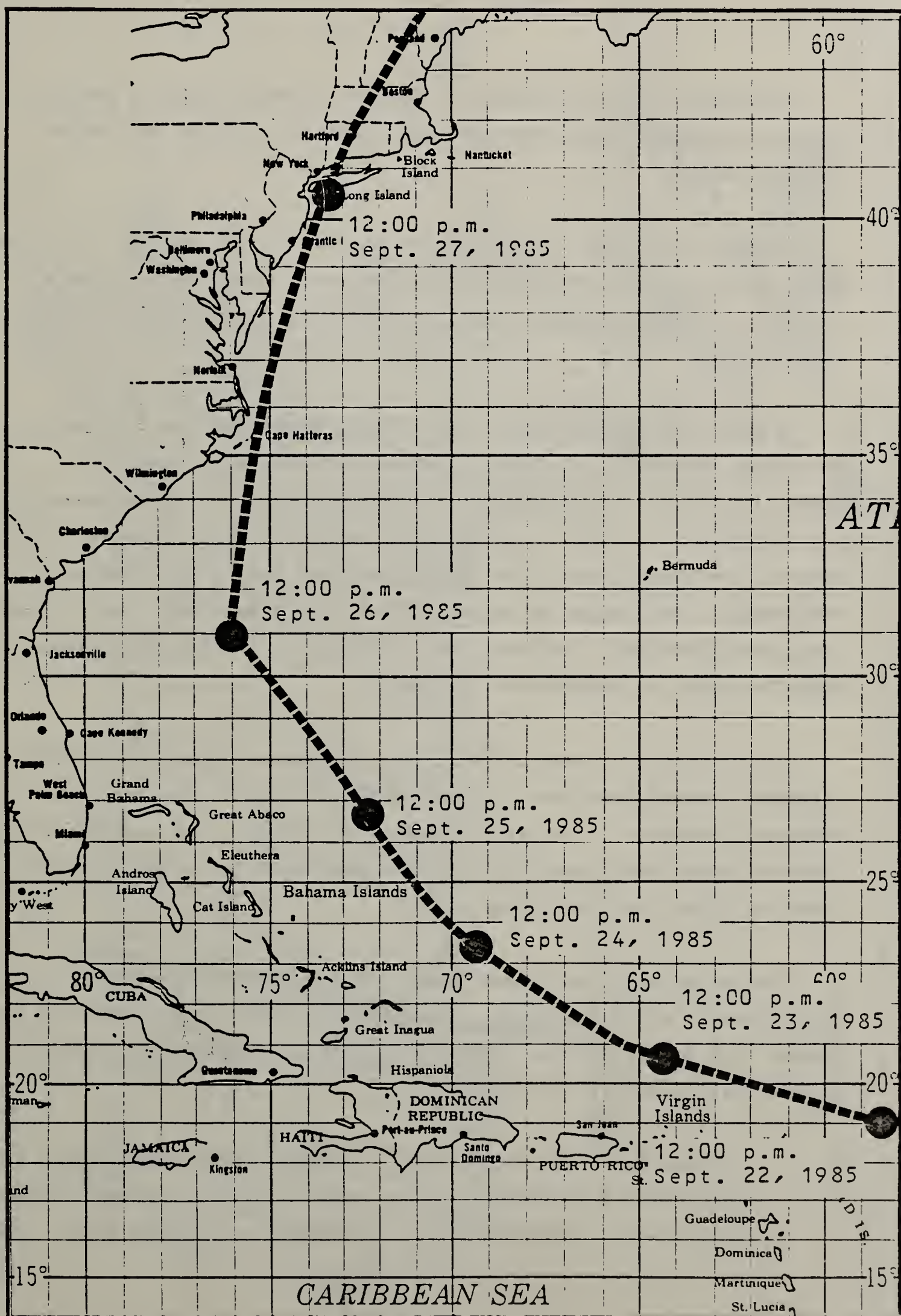


Figure 2. Complete track of Hurricane Gloria, September 22-27, 1985.

According to Peter Leavitt of Weather Services Corp in Bedford, Gloria's strength diminished when the storm encountered the cooler northern waters.

Leavett also said he believes a shallow trough of cool air lying along the south shore of Long Island may have pushed Gloria's more forceful hot spinning winds higher, diminishing their impact on land (Appendice B).

A hurricane warning went into effect from 10:00 a.m. to 6:00 p.m. EDT on Friday, September 27, 1985. The path of GLORIA followed the Connecticut River Valley and entered Massachusetts at approximately 2:00 p.m. September 27, 1985, passing on to Vermont at approximately 4:00 p.m. Because the Connecticut River Valley does not have a high degree of development, the damage sustained by the region was less than it might have been otherwise. TORNADOS were reported in southeastern Massachusetts from the towns of Seekonk and Rehobeth.

The rainfall in Massachusetts which accompanied Gloria was minor although several towns west of the Connecticut River did receive substantial amounts of rainfall (Figure 3). Clearly the peak wind speeds from the storm had diminished significantly with the highest speeds occurring along the coast (Figure 4).

The storm moved on to New Hampshire and Maine diminishing significantly as it travelled. Despite the rapid deterioration of this system, the following item from the October 4, 1986 Boston Globe attests to the lasting effect of Gloria.

Around here, we sort of lost interest in Hurricane Gloria after it moved up to Canada, but it didn't end its journey there. According to meteorologists in Switzerland, after Gloria left our

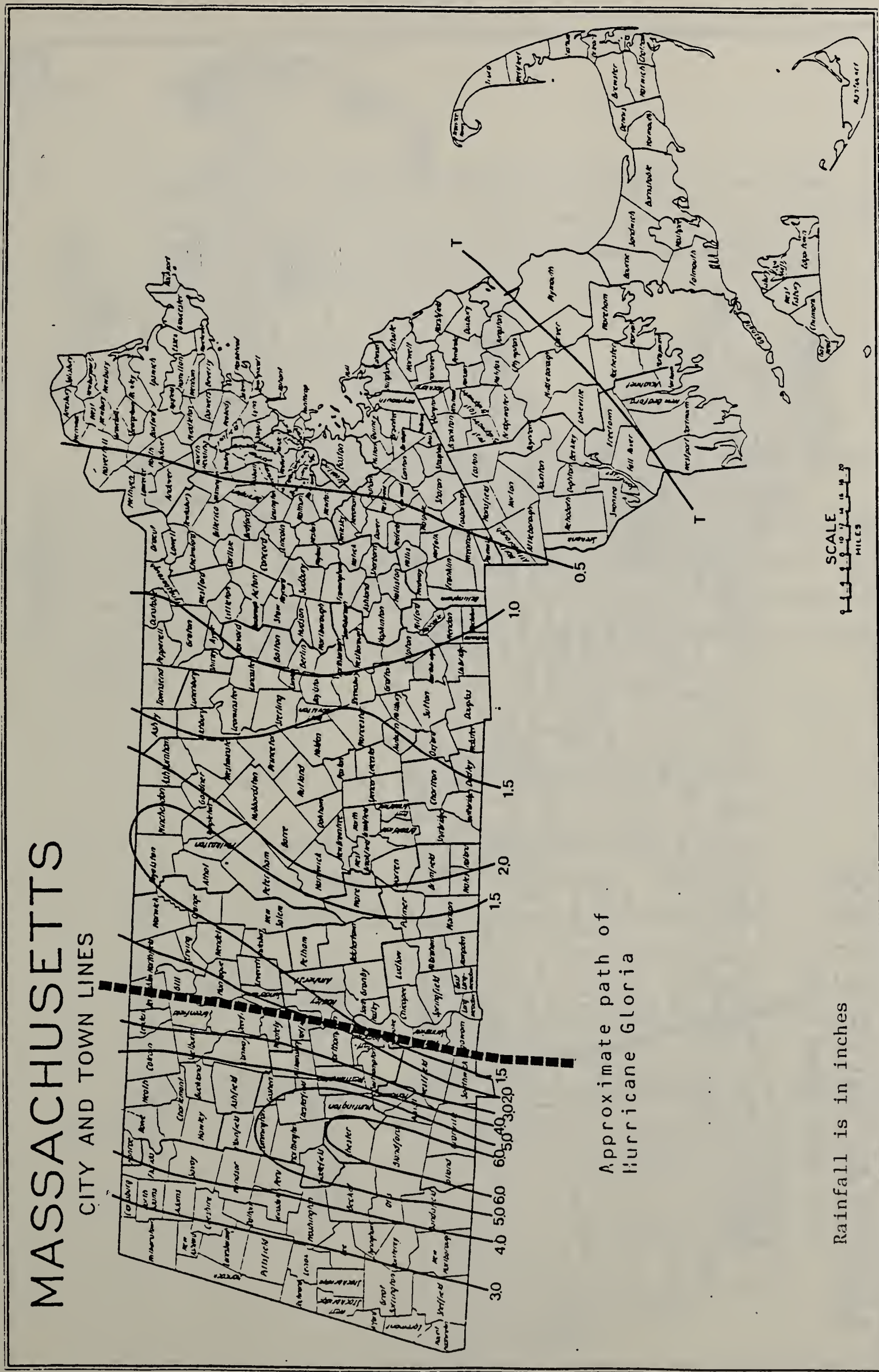


Figure 3. Rainfall distribution for Hurricane Gloria, September 27, 1985.

neighbor to the north, it formed a low pressure zone between Iceland and the Irish coast that brought warm air up into Europe from the south. It was 86 degrees in Basel yesterday, the warmest October 3 in Switzerland this century.

COST OF DISASTER

According to the Federal Emergency Management Agency Damage Survey Report of August 26, 1986 the total eligible damage of GLORIA was \$23,511,929.00. This figure does not include the damages which occurred statewide that were not considered eligible for federal assistance. State and local governments were responsible for contributing a 12.5% match each of the \$23,511,929.00. Accordingly, the breakdown of expenses are shown in Table 1.

Table 1. Cost Sharing For Eligible Damages

\$17,633,949.00	Federal share (75%)
2,938,990.00	State share (12.5%)
2,938,990.00	Local share (12.5%)
<hr/>	
\$23,511,929.00	100%

The categories these monies could be expended for are listed in Table 2.

Table 2. Damage Reimbursement Catagories

<u>Disaster Reimbursement Categories</u>	<u>% of Total Reimbursement</u>	<u>Total Eligible</u>	<u>Federal Share</u>
Debris removal	77%	\$ 18,142,882	\$ 13,607,162
Protective measures	7%	1,610,589	1,207,942
Roads & bridges	7%	1,550,006	1,162,505
Water control fac.	less than 1%	10,540	7,905
Public buildings	2%	560,584	420,438
Public utilities	6%	1,432,842	1,074,632
Private non profit	less than 1%	5,685	4,264
Other	1%	198,801	149,101

The percentages of monies committed for the designated catagories suggests the type of damages GLORIA produced. Wind damage was the most prevalent form of damage statewide as the 77% value for debris removal demonstrates.

Wind damage severely affected Massachusetts Electric Companies knocking out power and utility poles. According to Boston Edison's President and Chief Executive Officer, repairs would cost the company \$6 million.

Massachusetts agriculture also suffered significant losses from Hurricane Gloria. Although significant crop losses occurred, physical damage to farm buildings and facilities was also prevalent. The following information is taken from a U.S. Department of Agriculture Natural Disaster Damage Assessment Report of October 1985.

Table 3. Agriculture Service Buildings Damaged

County	Minor	Major	Loss
Bristol	5	5	\$50,000
Middlesex	7	1	\$ 3,500
Worcester	7	0	\$10,000
			<hr/> \$63,500

The impact of Gloria on agriculture translates into financial hardship in primarily two ways, one a drastic reduction in cash-flow for the upcoming year due to the reduced harvest and two, a shortage of feed for dairymen through the winter.

DESCRIPTION OF PREVIOUS EVENTS

Approximately 75% of development in Massachusetts has historically occurred along its coastal areas resulting in property and structures which are situated in locations highly susceptible to the effects of natural flood disasters. Extensive river systems exist across the state which often have their floodplains developed. Further inland, ravines and creeks are present which are prime sites for violent flash flooding incidents. Other non-flood hazards in Massachusetts include forest and urban fires, oil spills, earthquakes, tornadoes, toxic algae, and gas explosions.

Historically the worst natural disasters have been those which include the combination of several debilitating variables or environmental extremes. These variables include: low temperature, high wind, tidal surge, large amounts of precipitation, storm driven waves, and earthquakes.

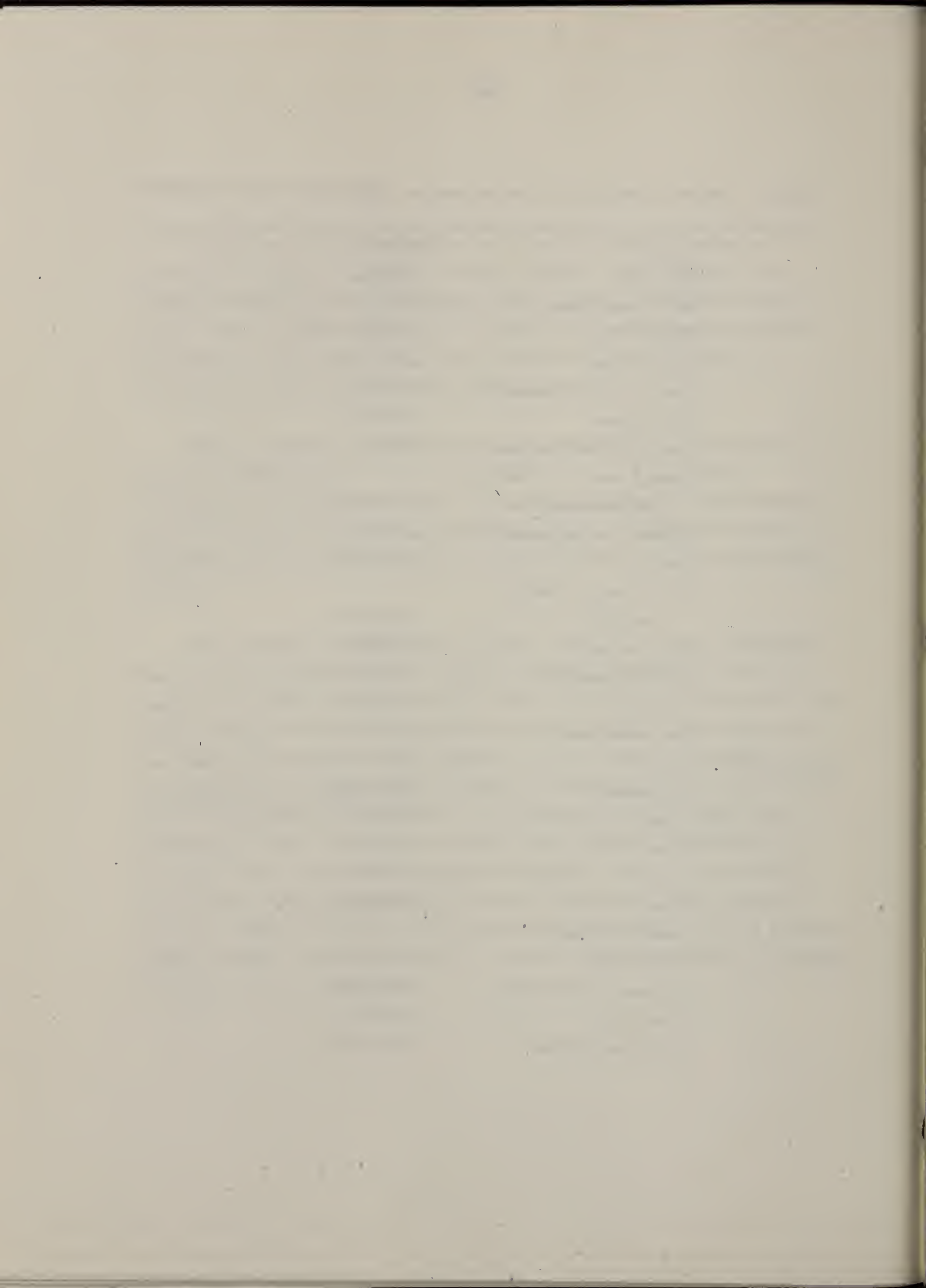
In some cases the occurrence of only one of these environmental extremes is enough to produce a natural disaster. For instance, an unusually high tidal surge has been known to cause significant damage within coastal communities even if no additional environmental extremes were present. Typically though the disasters on record include the occurrences of more than one environmental extreme.

Table 4 presents historical disaster information in chronological order for Massachusetts. Refer to Appendices C and D for further information concerning historical storms and disasters in Massachusetts. Appendix E includes disbursement information from the Federal Emergency Management Agency concerning seven (7) specific natural and technological hazards.

The Blizzard of February 6th and 7th, 1978 will long be considered the most devastating natural disaster to hit Massachusetts in recent memory. This Blizzard caused nearly \$300 million worth of flood and wind related damage in 46 coastal communities from Orleans, Massachusetts to New Castle, New Hampshire. See Appendix F for a summary from Blizzard of '78 Coastal Storm Damage Study prepared by the New England Division of the Corps of Engineers, February 1979. The Blizzard of '78 shocked the Commonwealth with the need to establish flood mitigation policies and strengthen its Coastal Zone Management Program. Since the 1978 storm, many coastal zone management measures have been implemented which will mitigate losses if a blizzard of equal characteristics as the '78 Blizzard repeats itself. Further information regarding these measures is presented in Chapter IV of this report.

Table 4. Natural Disasters In Massachusetts (FEMA DMIS Report 02/26/86)

Tornado	06/11/53
Hurricane	09/02/54
Hurricane/Floods	08/20/55
Forest Fire	05/15/57
Tidal Flood	01/02/60
Severe Storm/Flooding	03/06/72
Toxic Algae	09/28/72
Fire (City of Chelsea)	10/16/73
Urban Fire	
(Middleborough)	01/09/75
Natural Gas Explosion	10/10/75
Fire	12/15/75
Fire (Jamaica Plain -	
Boston)	02/06/76
Fire (Palmer)	04/28/76
Fire (Brockton)	04/29/76
Oil Spill	01/14/77
Ice Conditions	03/11/77
Fire	03/22/77
High Winds	06/02/77
Urban Fire	06/24/77
Fire	08/16/77
Fire	09/19/77
Fire	02/06/78
Coastal Storms,	
Ice & Snow	02/10/78
Blizzard & Snowstorms	02/07/78
Urban Fire	12/03/81
Hurricane(Gloria)	10/28/85



CHAPTER III

PROBLEM IDENTIFICATION

The nature of the damage caused by hurricane GLORIA varied across the state. High winds, and to a lesser degree flooding, were the chief environmental extremes which produced the most damage. If significantly greater amounts of precipitation and the resulting flooding occurred statewide, GLORIA could have been a historically devastating event.

EXTENT OF DAMAGE

Power lines of Massachusetts power companies were destroyed statewide. During the evening of Friday, September 27, 1985 the major Massachusetts electric companies reported that approximately 33% of their customers were affected by power outages. Boston Edison had to hire out of state contractors from Quebec, New York, Chicago and Cleveland to assist with the re-establishment of power to 200,000 of its 600,000 customers. That company received 2,000 calls an hour from its customers. As of Sunday evening September 28, 1985, 61,700 of Boston Edison's 850,000 Massachusetts/Rhode Island district customers were still without power, according to the Boston Globe of Monday September 29, 1985, outages in Southeastern Mass continued through the week.

Massachusetts agriculture was also severely affected. According to information from the U.S. Soil Conservation Service the counties of Bristol, Middlesex and Worcester suffered the combined losses illustrated in Table 5. The crops affected by these losses included field corn, sweet corn, apples, vegetable, cranberries, nursery stock, hay and pears. Apples, pears and corn suffered the most damage.

Table 5. Agricultural Production Losses:
Bristol, Middlesex, and Worcester Counties

Percent Production Loss	Number of Farmers
100 %	6
90 - 99	0
80 - 89	0
70 - 79	30
60 - 69	60
50 - 59	150
40 - 49	131
30 - 39	235
20 - 29	389
Less than 20	105
	1,106

Town roads were severely damaged in those communities which received heavy rains. Damage varied between dirt roads and paved roads. Dirt roads became severely eroded. Paved roads became undermined and in some cases buckled.

The term "damage" suggests the destruction of property. However, during GLORIA significant costs were associated with cleaning up debris and paying Public Safety officials for protective measures. In these cases damage to property did not occur yet costs were incurred.

CAUSE OF DAMAGE

Most of the damage caused by GLORIA was wind related and more difficultly addressed. City and town tree maintenance funding cutbacks have resulted in reduced tree care and increased public safety risks. Although some state funding exists to assist communities it does not replace the lost funding due to local shade tree program cutbacks.

Placement of utility wires underground, which is easily done in new developments, is one of the most effective mitigation options available for protection against wind damage.

Although flooding during GLORIA was minor statewide, it severely impacted several communities. Since hurricane characteristics differ widely it was not unusual for heavy precipitation to be confined to a relatively small area. According to information from Guidelines for Soil and Water Conservation in Urbanizing Areas of Massachusetts (S.C.C., 1975) the storm frequency in the vicinity of Chester and Blandford was approximately a 30 year frequency. Since this rainfall occurred in a relatively small watershed it was reasonable that Chester and Blandford did experience the flash flood difficulties they had.

Fortunately there were conditions during GLORIA which prevented the storm from causing greater damage. For instance, if more rain had fallen statewide a greater number of tree blowdowns would have occurred because the moist soil would have permitted tree roots to loosen more readily. Also, the passage of GLORIA through Massachusetts coincided with low tide. If GLORIA hit Massachusetts during high tide the tidal surge would have undoubtedly flooded low lying coastal areas. This factor alone may have held the damage costs of GLORIA to a fraction of what they would have otherwise been.

ADDITIONAL HAZARD IDENTIFICATION

The Federal Emergency Management Agency (FEMA) requested from the Massachusetts Civil Defense Agency (MCDA) information relating to hazard identification by local communities. MCDA distributed a questionnaire and received responses from seventy seven (77) communities. This data was used to compile the Hazard Identification Capability Assessment and Multi-Year Development Plan for Local Governments (November, 1985). According to this data (Table 6) hurricanes and winter storms were ranked as the top two priority hazards by virtually all the reporting communities.

Table 6. Hazard Identification Capability Assessment and
Multi-Year Development Plan For Local Governments

Priority	Disaster	Number of Communities Selecting Priority
1	Hurricane/Tropical storm	77
2	Severe Winter Storm	77
3	Highway Hazardous Material Incident	72
4	Hazardous Material Incident Stationary	53
5	Rail Hazardous Material Incident	50
6	Urban Fire	40
7	Power Failure	38
8	Flood	31
9	Pipeline Hazardous Material Incident	27
10	Tornado	27
14	Earthquake	16
16	Dam Failure	13

Some hazards have a greater possibility of occurring in communities because of the geography of the community or the character of the community's development. For example, hazardous materials incidents are high on the priority list not only because of increased awareness concerning public health and toxic materials safety but because all communities have highways and nearly all have industrial facilities and railways. Just over half of the questionnaire respondents excluded urban fires as a priority hazard. This is likely since many of the reporting communities do not have densely developed urban areas. Similarly, some communities may not have waterways of a significant size to present a threat of flooding. Although tornados do occur in Massachusetts they have not tended to be the destructive power houses associated with tornados in other parts of the nation.

Based upon a brief analysis of this hazard identification information it is obvious why hurricanes/tropical storms and severe winter storms are ranked as number one and number two respectively on the priority list. These hazards impact all communities and all residents. Local governments can easily deplete their financial resources to contend with the consequences of these hazards. The responsibility for clean up of other hazards (i.e. hazardous materials, power failure, pipeline hazards) may be in the hands of business, industry, or utility companies. In these cases government expenditures would not occur until the private sector demonstrated an inability to address an incident at hand. An additional reason why hurricanes and winter storms may be such high priority is that their recurrence is assured sooner or later and town officials must attempt to plan accordingly.

As part of the previously referenced Hazards Identification Study, municipalities were surveyed for their ability to prepare and respond to certain hazards. The data in Table 7 is presented to illustrate the number of communities reporting high, moderate and low capabilities for hazard analysis and mitigation.

Table 7. Local Capability For Implementing
Hazard Analysis and Mitigation

Implementation Capability	Responding Communities	
	Total	Coastal
High range - strong program	19	3
Moderate range - general ability exists but weaknesses prevail	53	10
Low range - limited ability to conduct basic emergency activities	5	0
	77	13

The data presents three initial observations. The figures indicate that none of the coastal communities are in the low range which is encouraging since coastal communities have historically been highly vulnerable to hurricanes and winter storms. The figures also present the discouraging fact that a substantial bulk of the communities are in the moderate range. The fact that only 77 of 351, or roughly 31%, of the Massachusetts municipalities returned the questionnaire infers a disappointing conclusion that municipalities view hazard identification as a low priority in their long-term planning efforts.

CHAPTER IV

INVENTORY OF EXISTING MITIGATION MEASURES

PRINCIPAL STATE PROGRAM ACTIVITIES

Flooding problems in Massachusetts are addressed by over 22 agencies in two major areas: 1) emergency response and recovery and 2) flood hazard mitigation. Five of these are specifically cited for their responsibilities and authority during emergency conditions. Three agencies are cited for a combination of responsibilities in disaster response and mitigation. Fourteen agencies are cited for their responsibilities and authority in flood hazard mitigation to a limited extent. Since the primary objective of this agency assessment is directed toward making recommendations to improve coordination among agencies in flood hazard mitigation activities, only those 14 agencies responsible for mitigation will be further summarized and addressed for specific recommendations.

Executive Office Of Environmental Affairs

To a limited extent, floodplain management activities in the Commonwealth are addressed through both regulatory and nonregulatory functions within the Executive Office of Environmental Affairs. Wetland Protection legislation is the primary legislative authority to condition and prohibit development in the floodplain. Permitting responsibilities exist within the Department of Environmental Quality Engineering. Four regional offices maintain technical and planning staffs to review orders of conditions written for individual projects by local Conservation Commissions. Storm damage prevention and flood control are just two of seven statutory interests protected.

Nonregulatory functions including wetland mapping, data collection and storage, acquisition, education, and technical assistance exist within the Secretary's office and the Department of Environmental Management. The Massachusetts Coastal Zone Management Program (MCZMP) and the Division of Water Resources have lead roles in coordinating project review, technical assistance and education and maintaining an inventory of National Flood Insurance Program (NFIP) studies, a federal liaison and an interpretive service of flood data, respectively. Staff expertise and program involvement in coastal and riverine flooding problems distinguish one program from the other. The MCZMP is exclusively concerned with coastal flooding issues, whereas, The Division of Water Resources also addresses riverine flooding issues.

No single state division or department coordinates all floodplain management activities therefore several conflicts and gaps within principal program activities exist. Areas of conflict or overlap include permitting of private and public uses, educating public officials, and interpreting floodplain management information. The primary gaps in floodplain management include: 1) coordination of other state, federal and local efforts, per se; 2) preparing model ordinances; 3) undertaking land acquisition specifically for flood hazard mitigation purposes; and 4) monitoring development.

A summary of selected agencies and the floodplain management activities for which they are responsible has been compiled in Table 8.

Table 8. Summary Of Selected State and Local Program Activities In Floodplain Management.

DEPTS./DIV./PROGRAMS	* PRINCIPAL STATE PROGRAM ACTIVITIES													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
State: Executive Office Environmental Affairs														
Administration														
Coastal Zone Management			X			X			X		X			
Conservation Services														X
Environmental Policy Act							X	X						
Dept. Environmental Quality Engineering														
Wetlands Protection			X	X		X	X	X	X		X		X	
Waterways							X				X			
Water Pollution								X						
Dept. Environmental Management														
Water Resources	X		X			X								
Wetlands Restriction		X	X			X			X					X
Scenic Rivers		X		X	X									
Planning														X
Metropolitan District Commission														
Parks								X						X
Local														
Conservation Commission	X					X	X							X
Planning Board	X	X					X						X	
Health Board								X						
Building Inspector	X					X	X							
Zoning Board of Appeals							X							

*

See Table 9. for explanation of Program Activities in Floodplain Management.

The following assessment of the key programs within the Executive Office of Environmental Affairs is based on material presented in Strengthening State Floodplain Management, a report compiled by the Association of State Floodplain Managers. Concise listings of principal program activities (Table 9) and key elements (Table 10) in floodplain management enable a consistent approach to assessment and serve as a basis for recommendations to improve agency coordination.

Table 9. Principal State Program Activities in Floodplain Management
(from ASFPM).

- 1) Disseminating information on the National Flood Insurance Program and assisting FEMA to implement the Program;
- 2) Mapping floodplains and providing assistance to federal mapping efforts;
- 3) Establishing and maintaining data storage and retrieval systems;
- 4) Establishing minimum standards for local programs;
- 5) Preparing model ordinances and manuals;
- 6) Assisting in the interpretation and use of floodplain data;
- 7) Processing permits for private floodplain uses;
- 8) Reviewing and regulating public uses such as roads and bridges;
- 9) Educating local officials and the general public through workshops, preparation of materials and one-on-one consultations;
- 10) Preparing disaster mitigation plans and assisting other agencies in preparation of such plans;
- 11) Assisting localities in evaluating various flood damage reduction alternatives;
- 12) Coordinating other state, federal and local floodplain management efforts;
- 13) Monitoring floodplain development and;
- 14) Undertaking supplementary floodplain management measures such as land acquisition.

Table 10. Key Elements In State Floodplain Management Programs
(From ASFPM).

- 1) A "lead" floodplain coordinating agency to provide technical assistance and education;
- 2) Adequate funding to provide expert staff and mapping, monitoring and enforcement;
- 3) Expert staff with specific training in floodplain regulation;
- 4) Statutory authority to directly regulate floodplain uses;
- 5) Statutory authority to provide for nonregulatory floodplain management techniques;
- 6) Adopted rules or regulations to supplement statutory provisions;
- 7) Mapping and data collection capabilities;
- 8) Technical assistance provided to communities, other state agencies and private landowners;
- 9) Continuing educational support for anyone dealing with floodplain activities and;
- 10) Pre- and Post-flood hazard mitigation planning.

Massachusetts Coastal Zone Management Program (MCZMP)

Under authority of the CZM Act of 1972, (P.L. 92-583 Section 306) MCZMP has a purpose to protect and carefully manage the development and use of the Commonwealth's coastal zone. This is largely accomplished through existing government programs guided by 27 coastal zone management policies, of which thirteen are regulatory and fourteen are non-regulatory. The thirteen regulatory policies include 1) protection of ecologically significant resource areas, 2) protection of complexes of marine resource areas of unique productivity and 3) conditioning of construction in water bodies and contiguous land areas. Three of the nonregulatory policies are: 1) ensuring proper use of funds for State and

Federal public works projects within the 100 year coastal floodplain, 2) encouraging acquisition of hazard prone areas and 3) providing technical assistance for hazard mitigation and funding for non-structural flood and erosion measures. These regulatory and non-regulatory policies are specifically cited for better planning and management approaches to solving coastal hazard problems.

The MCZMP also provides direct and indirect financial, administrative and technical assistance to coastal communities as well as other state agencies. The MCZMP is implemented through a variety of tasks which include support of appropriate coastal development, wetlands protection and restriction programs, a tidelands licensing program, an improved fisheries management program, planning for the siting of energy facilities in the coastal zone, identification of areas of critical environmental concern, improved management of and consistency between State and Federal projects and activities, improved administration of existing laws, and provision for the continuing review of Outer Continental Shelf oil and gas exploration and development.

The MCZMP plays a large advocacy role in promoting sensible management of land use in the coastal zone. One of the main issues they advocate is improved coastal hazard planning (i.e. storm prevention and flood control) and for purposes of discussion, is considered as floodplain management. The principal activities include: 1) assisting in the interpretation and use of floodplain data, 2) educating local officials and the general public through workshops and the preparation of materials and one-on-one consultations, and, 3) assisting localities in evaluating various flood damage reduction alternatives. To a limited extent, MCZMP is establishing and maintaining data storage and retrieval systems and through Executive Order No. 181, the program is prioritizing a supplementary floodplain management measure of promoting the acquisition of barrier beaches.

In August, 1980, the signing of Gubernatorial Executive Order No. 181 directed state agencies to adopt strict policies to limit state subsidized development of hazard prone barrier beach areas. Priority status was also accorded these areas for Self-Help and other state and federal acquisition programs and were also incorporated into the Statewide Outdoor Comprehensive Recreation Plan. Controls were also placed on the use of state and federal funds, engineering structures and dredging in the areas of barrier beach systems. The non-regulatory technique of implementing Executive Order No. 181 on Barrier Beaches highlights the innovative capability of the MCZM Program.

The key elements in the MCZM floodplain management efforts have been endangered due to a doubtful future for the continuance of federal funding. In 1983 the Commonwealth established the MCZM program by legislation and now supports 50% of the program funds. It is important to recognize the strong part CZM plays in floodplain management.

Since its inception in April 1978, the MCZMP has maintained a coordinating function in all aspects of its program, particularly wetland protection and environmental regulation. Much of this responsibility is related to Federal Consistency Review requirements. It has had the authority to coordinate activities and provide technical assistance and education. An obvious limitation to this office serving the state as a sole floodplain management coordinating agency is its concentration on the coastal zone only and no participation in inland flooding problems.

Although short-term, federal funding is a limiting factor, expert staffing, some mapping, technical assistance and public education are currently supported. Presently a full time coastal geologist, marine biologist, cartographer and several regional planners comprise the CZM staff and are available for assistance to floodplain management problems.

Also, coastal hazard mapping is being exclusively produced within the program. In 1985 a coastwide historic shoreline change mapping project was completed. A total of 231 map panels cover the coast of Massachusetts. Each map is at a scale of 1:5000 (one inch equals 400 feet) and identifies three historic shorelines and one recent shoreline. Other maps and resource data stored in house include topographic maps, nautical charts, some soil maps and shoreline erosion maps and data.

As one of the strongest capabilities within the program, MCZMP assists town boards, government agencies and the general public in map interpretation, acquisition strategies, and case-by-case project review.

A continuing educational support for understanding environmental laws, rules, and regulations, wetland resource functions, coastal hazards and state policy is another strength of the MCZMP.

Division of Conservation Services

Under the authority of MGLA Ch. 2, S. 18-25, three major activities are handled by this division, two of which are grant programs. They include: 1) Land and Water Conservation Funds (federal law), 2) Self-Help funds (MGLA Ch. 132, S.11) and, 3) Conservation Restrictions (MGLA Ch. 184, SS. 31-33). These activities give one state division the authority to preserve lands for recreation, open space and restricted use. The Self Help program is primarily an acquisition fund. The Land & Water Conservation Fund which is partially federally funded is for both acquisition and recreation facilities construction. Additionally, the Urban Self Help Program funding is to be directed to projects which are of regional or statewide significance. Projects have involved barrier beaches, wetlands, recharge areas and forests.

The understanding of supplementary floodplain management measures such as land acquisition is a direct responsibility of the Division. The Self Help program has awarded millions of dollars since the program's beginning in 1976. Much of this money has been spent for the acquisition of low lying floodplain areas. Indeed the protection of "water resources" is a high priority item considered during the application rating procedure. Under the "water resources" section of the rating process an application can earn a full ten points. "Water resources" include floodplain management as well as aquifer recharge areas, access for water-based recreation etc.

A random sampling of Self Help and Urban Self Help acquisitions include the following.

<u>Municipality</u>	<u>Description of Acquisition</u>
Newton	3/4 mile along Charles River
Mashpee	1 mile along intertidal river in high growth Cape Cod region
Dennis	3/4 mile along intertidal river in high growth Cape Cod region
Norwell	3/4 mile riverfront along North River
Taunton	1/4 mile riverfront along Taunton River near urban downtown area
Dover	1/2 mile riverfront along Charles River, upstream of urban area

These riverfront acquisitions address only a small sample of the Self Help program accomplishments of the Divisions. Many of the Self Help riverfront acquisitions include not only riverfront land but substantial amounts of upland or non floodplain areas.

The inflation of coastal property values in Massachusetts has risen drastically since the inception of the Self Help Program. This has caused the original fund for the Self Help program to become depleted earlier than anticipated. According to the September 1986 issue of Coastlines, a journal from the Massachusetts Coastal Zone Management Agency, the amount of money available for coastal acquisitions is far behind the need. "By the July 1st (application) deadline, 54 fundable Self-Help applications had been received for 1987 proposing to purchase 2,500 acres valued at more than \$31 million. Half of these proposals are for properties valued at an astounding \$21 million." Certainly the acquisition of coastal areas would be an effective floodplain management action the Commonwealth could take. With the passing of Executive Order No. 181 on barrier beaches, the Division is developing a policy for use of Self-Help and Urban Self-Help conservation funds toward projects involving barrier beaches, water supplies, and natural heritage areas. Reimbursements ranging from 75-90% of the cost of acquisition of barrier beaches will be provided. Clearly, this is an established flood hazard mitigation policy.

Any community which applies for one of the grant programs must have an approved "Open Space and Recreation Plan" on file with the Division. These plans are a detailed inventory of open space and recreation resources of a given community with projections of goals and objectives which the community intends to implement. These plans address a wide range of issues including water supply and water resources issues. The intent of requiring the plan is to have the community demonstrate how thorough and well thought out their open space and recreation planning is before awarding grant money.

The Division of Conservation Services also provides funding for Conservation Districts. The sixteen Conservation Districts were created in 1947 to assist farmers and private landowners with soil erosion and

water problems. The districts coordinate the delivery of technical and financial assistance from several State and Federal natural resource agencies. Today the districts provide technical assistance and also financial assistance for municipal planning through the Open Space Planning Grants. Municipalities address floodplain management in their Open Space and Recreation Plans.

The Massachusetts Environmental Policy Act (MEPA)

Under the authority of MGLA Ch. 30, S. 61 and 62, MEPA establishes an environmental review process for State actions, projects with State funding, or projects requiring permits or licenses from State agencies. Essentially an environmental full disclosure law, the intent of MEPA is to improve environmental planning and design "so as to minimize and prevent damage to the environment."

MEPA does process permits for private floodplain uses and reviews public uses (i.e. infrastructure) through an Environmental Notification Form (ENF) process. This greatly contributes to the synthesizing of information and coordination of review comments by state agencies and the public. Citing key elements of a floodplain management program is difficult, however. Competent staff seek and obtain technical knowledge in order to process reviews and then are able to educate project proponents, but, the central issue of floodplain management is only one of many issues (ie. air quality, groundwater protection, traffic impacts, etc.) that must receive consistent attention.

Department of Environmental Quality Engineering

Division of Wetlands and Waterways Regulation

Wetlands Protection Program. Under MGLA Ch. 131, S. 40, DEQE gives Conservation Commissions authority to review proposals for projects

in wetlands (including permitted use projects in restricted wetlands). The purview of the Act extends to 100 feet beyond either the 100 year floodplain or the landward edge of a wetland, whichever distance is the greatest. All dredging, filling or other alteration in these areas is unlawful without first filing a Notice of Intent, both with the local Conservation Commission and the Commissioner of the Department of Environmental Quality Engineering. The Conservation Commission issues an Order of Conditions either conditioning or prohibiting the activity based on the probable impact on the seven interests of the Wetlands Protection Act -- public and private water supply, flood control, storm damage prevention, prevention of pollution, protection of land containing shellfish, or the protection of fisheries. An Order of Conditions may be appealed to, or by, the Commissioner of DEQE.

As the primary state permitting authority in wetlands, DEQE is probably the most active department in floodplain management for the state and has five direct and three indirect responsibilities in floodplain management. Processing permits for private and public floodplain uses is the principal activity, with interpretation of floodplain data, establishing minimum standards and educating the public as secondary activities. In limited cases, maintenance of data, assistance to localities in evaluating flood damage reduction alternatives and monitoring floodplain development are also pursued.

Wetlands Restriction Program. Under the authority of MGLA Ch. 130, S.105, the Commissioner of the Department of Environmental Management, after a public hearing is authorized to restrict wetland areas against most types of environmentally harmful development. Barrier beaches, dunes, salt marshes, shellfish beds, salt ponds and fresh water wetlands in Massachusetts will be restricted under this program, with the exception of those in designated port areas, those under MDC control, or mosquito control projects operating under MGLA C. 252. Approximately 40%

of all eligible coastal areas have been restricted to date. In general, filling, draining, or dredging of wetlands, the discharge of hazardous substances, or any act that would destroy natural vegetation, alter existing tidal flow, or otherwise result in the alteration of the natural and beneficial character of these areas, is prohibited. Permitted uses include piers, wharves, duck blinds and so on, essential energy transmission lines and upkeep of existing roads.

Local Conservation Commissions issue an Order of Conditions for permitted uses. A landowner can appeal to the Commissioner within 60 days after restriction orders are proposed. Specific language of Restriction Orders is developed on a town by town basis. A two-thirds vote of Massachusetts Legislature can repeal a restriction order.

One direct and several indirect activities occur within the Restriction Program. Educating local officials and specific landowners having wetland property of the habitat value and hazard vulnerability through information and public hearings, preparation and distribution of informative materials and one-on-one consultations during on-site visits are a major focus of the program. Other activities include mapping wetlands on orthophoto base maps at a scale of 1:5000, maintaining wetland data and statistics, and assisting in the use of floodplain data upon request. Currently, the program is funded by a 50/50 federal state match with supplementary funds for mapping.

The program is unique in its deed restriction approach. The landowner is fully aware of the projects which may be regulated and those that are directly prohibited. The order also gives guidance to regulatory authorities on the range of possible projects that are appropriate.

Although not required by statute, the coastal program promulgated regulations in 1978 based on a recommendation by the Attorney General's office. Shortly thereafter, rules for the inland program were also passed. The prime source for wetland mapping for the state exists within the Restriction Program. Contracts are let on a regional basis and since 1978, three quarters of the state's coastline has been mapped. Progress in the inland areas is slow. Sets of topographic, nautical and some soils maps are maintained. In addition, a collection of ground and aerial oblique photos (in slide form) have been cataloged for a majority of the coastline south of Boston, including the islands.

Waterways Program (Coastal). Under authority of MGLA Ch. 91, S. 1-59 the program is administered by DEQE, has jurisdiction over filling, construction of any new structure, dredging, or removal of sand and vegetation in tidelands, harbors and certain rivers below the high water mark. All land below extreme low water is managed as a Public Trust by DEQE and permission to utilize these lands is given in the form of licenses. Although land between high and low water is privately held, no activity that interferes with the reserved public rights for fishing, fowling and navigation in this area is permitted.

Waterways is involved in two principal floodplain activities: 1) processing permits for private floodplain uses and 2) assisting localities in evaluating various flood damage reduction alternatives. Permits relating to flood control projects and shore protection works have primarily been structural in nature. In addition, the technical assistance to localities has centered upon structural alternatives to solve shore protection problems. An emphasis on the use of non-structural solutions as a primary method on barrier beaches has recently been adopted in response to Executive Order No. 181 and the hiring of new expert staff. Any shore protection and flood control structures located below

mean high water must receive a chapter 91 license as authorized by MGLA Ch. 21A, S.2. The promulgation of rules and regulations occurred with assistance from MCZMP in 1980 to clarify the program's standards for flood control works. As a result of Legislative amendments to Ch. 91 in 1983, new regulations are being drafted and are scheduled for promulgation in early 1987. These new regulations will reflect a higher awareness of coastal flooding problems.

Waterways Program (Inland). M.G.L. Ch. 253, S. 44-47 transfers the responsibility of the inspection of dams, public or private, from the county commissioners to DEQE and directs the Commissioner to promulgate regulations classifying dams according to the potential for damage to life or property.

Division of Water Pollution Control

Grants For Construction of Collection Systems - M.G.L. C.21, s. 30A authorizes the Division to "make grants to public entities for the cost of constructing collection systems." Grants can not exceed fifty percent of the project cost and are made in accordance with a priority system.

Grants For Construction of Wastewater Treatment Facilities - Subject to the provisions of P.L. 97-117, the Division awards financial assistance to municipalities for planning design and construction of wastewater treatment facilities.

Both of these grant programs provide financial assistance for the construction of facilities that could be located in flood hazard areas. The Division presently scrutinizes grant applications and construction designs to ensure flood hazards are eliminated or mitigated. It is essential for this practice to continue.

Department of Environmental Management

Division of Water Resources

The Division of Water Resources (DWR) is responsible to the Massachusetts Water Resources Commission for the study of the needs, supplies and resources of the Commonwealth with respect to flood damage prevention. This responsibility is implemented by the following:

- (1) actively encouraging and participating in the planning phase of floodplain management through studies made by organizations such as the U.S. Corps of Engineers, U.S. Soil Conservation Service and adjoining states.
- (2) accumulation of basic data including the recording of precipitation, stream gauging snow surveys and flood monitoring for the purpose of flood control planning.
- (3) implementation of P.L. 566 Watershed Protection and Flood Control Prevention Act Program, which funds the construction of flood control structures.
- (4) state coordinating agency cooperating with the Federal Emergency Management Agency (FEMA) in selection of priorities for rating studies and the distribution of completed flood maps and reports.
- (5) the Flood Hazard Management Program (FHMP), under DWR, is involved with reviews under Executive Order 11988.

The Commonwealth's concern regarding flood hazard mitigation was further expressed in November, 1978 when Governor Michael S. Dukakis issued Executive Order No. 149 which provided for "state coordination and participation with the federal administration under the National Flood Insurance Act of 1968." The order designated the Massachusetts Water Resources Commission as the state coordinating agency to assist in the implementation of the National Flood Insurance Program NFIP, to implement the floodplain management criteria for state-owned properties in special hazard areas and to make recommendations as to areas eligible for hydrologic rate making studies as required by Flood Insurance Administration (FIA).

Flood Hazard Management Program (FHMP). The FHMP is the primary state program established for the specific purpose of floodplain management practices concerning the National Flood Insurance Program. Since 1978 the FHMP has provided the following floodplain management assistance measures to municipalities and or individuals:

- * development of floodplain management by-laws
- * interpretation of National Flood Insurance Regulations
- * interpretation of Massachusetts Building Code Section 744.0 Design Requirements for Floodplains and Coastal High Hazard Areas
- * field inspections of community floodplains and follow up discussions with town officials
- * distribution of technical publications and Flood Insurance Rate Maps
- * coordination of floodplain management policy understanding between various state agencies involved with wetlands, floodplains, coastal high hazard areas, etc.
- * direct the conversion of municipalities from the emergency phase of the National Flood Insurance Program to the regular phase of the NFIP, which affords property owners greater flood insurance protection

- * identify flood hazard mitigation land use options for coastal communities through development of municipal "open space and recreation plans" with municipal planning staff
- * coordinate acquisition of floodplain property through the FEMA 1362 program in Massachusetts communities.

Table 11 lists the status of community participation in the NFIP (based upon March 1986) of which the FHMP facilitates.

Table 11. Status Of Community Participation In The NFIP

Number of Massachusetts municipalities	351
Number in NFIP	320
Number in regular program	295
In regular program but having no Special Flood Hazard Area	1
In regular program but minimally flood prone	6
In emergency program	25
Suspended from NFIP	6
Not in NFIP but have Special Flood Hazard Area identified	24

As real estate values soar, coastal and high growth communities are under severe pressure to develop marginal lands. The municipal officials of these communities (i.e. building inspectors, planning boards, conservation commissions) often do not have the time and/or support staff to thoroughly monitor floodplain management issues under their authority. The FHMP's role in providing community assistance in these cases is critical for flood hazard mitigation statewide.

Scenic Rivers Program. Under the authority of MGLA Ch. 21, S. 17b, the program provides for the designation and restriction of rivers for scenic and recreational purposes. The Scenic Rivers Program designates irreplaceable Massachusetts river resources and subsequently identifies procedures for protective stewardship of these resources. Rivers are classified according to the following five categories:

Category 1	Natural
Category 2	Scenic Natural Landscape
Category 3	Scenic Cultural
Category 4	Recreational Natural Landscape
Category 5	Recreational Urban

Currently forty eight (48) rivers have been classified with a total of 1,700 miles of corridors established. Numerous other rivers have been nominated but were not considered eligible. This program is valuable for floodplain management purposes because it recognizes the importance of Scenic River floodplains maintained in their natural condition. Through citizen interest groups, property owner awareness and ordinance and zoning bylaw adoption the Scenic River floodplains are protected in a manner which monitors development closely and encourages the continued flood storage capabilities of these floodplains. Although the above mentioned local protection measures are the most prevalent for these river corridors a state protective order exists which records specific restrictions on deeds of land bordering a scenic river. Clearly this authority would more thoroughly protect Scenic River floodplains.

Land Acquisition Program. The D.E.M. land acquisition program has specifically defined criteria used to evaluate a possible acquisition. The most important criteria is whether or not the property is of regional or statewide significance. Significance of the resource could be a

combination of recreational, cultural and or natural value. Coastal properties have recently received aggressive attention by the program because so few significant coastal properties remain which become available for acquisition. The property evaluation and rating procedure enables floodplains, wetlands and coastal resources to receive extra points. If a proposed property does not score very high during the evaluation review the program staff coordinates the investigation of alternative property protection options such as management by private non profit organizations, establishing a Conservation Restriction or Agricultural Preservation Restriction. In some cases a commission of interested parties will evolve to protect a region such as the Connecticut River Action Program which has 37 active members.

Division of Waterways

The Division of Waterways administers a variety of programs many of which have clear flood mitigation objectives. The following outline lists the Division's programs:

Rivers and Harbors Program. Identifies the needs for improvements and renovations to waterways (ie. dredging, construction, and maintenance of structures).

Waterways Program. Involves dredging and channelization; design and construction or rehabilitation of piers, wharves, bulkheads, seawalls, groins or jetties; river and streambank erosion control; pond dredging and rehabilitation; beach nourishment, boat ramps and public access facilities; harbor debris removal; and river and stream clearance.

Dams. Includes the study, design and rehabilitation of existing structures.

State Piers. DEM has authority over state piers at Gloucester, New Bedford and Fall River.

Public Access. Includes the design and construction of marinas, boat ramps, boatways on coastal and inland waters.

The Division's time is split between coastal projects and inland projects. Along the coast most of the projects involve dredging and clearing of channels for recreational purposes. For inland projects waterways dredging and stream bank protection have required most of the Division's time. These inland projects are specifically to mitigate flood hazard risks. The Division acts as an administering agency which represents the Commonwealth in contractual agreements. Because the Division does not have the heavy equipment, staff, etc., to perform the duties outlined in the program it therefore hires consultants.

Division of Forest and Parks

Bureau of Recreation

The state Division of Forests & Parks manages approximately 140 open space recreation areas totaling approximately 260,000 acres. Of these 140 areas, 112 (80%) contain water resources which may be an ocean beach, inland river or pond. These floodplain areas are protected from alterations because they are state owned properties. Additionally the presence of Division staff enhance floodplains management by performing some of the following duties:

- * conduct beach grass planting and sand dune preservation projects
- * patrol remote areas to prevent filling, encroachment, etc.
- * clear culverts, channels, etc. of brush and obstructions
- * control visitor activities which accelerate run-off (i.e. trail use, high density group recreation, unauthorized use of resource protection zones).

Division properties have long range management plans created to understand what the most appropriate use of a park's resources may be. The development of these plans has been standardized according to a planning program entitled Guidelines for Operations and Land Stewardship (G.O.A.L.S.). Through this program a team of forest and park management

and planning professionals together with technical specialists and interested representatives from the public designate the following special use and protection zones:

- * Unique resource zone
- * Environmental Protection Zone
- * Natural Resource Management Zone
- * Development Lands Zone

Watercourses, ponds and wetlands are identified through this planning procedure and recognized for their flood storage value.

Bureau of Shade Tree Management

Although floodplain management programs are considered the primary natural hazard mitigation initiatives in the state there are programs which attempt to address shade tree maintenance which results in improved public safety. Each city and town in Massachusetts has a designated shade tree warden. This person is responsible for monitoring the health and public safety risks of shade trees on public property. An important aspect of this duty includes addressing nuisance insects and tree disease. An un-healthy or weak tree has a greater likelihood of falling and must therefore be carefully monitored. Town Tree Wardens receive a variety of support and funding depending on individual town policies and priorities. However in 1980 a referendum vote approved a property tax cap by cities and towns which seriously affected the generation of local revenue. "Proposition 2 1/2" restricted local property taxes to rise no more than 2 1/2 percent each year. Shade tree management programs are often considered a low priority and have not received adequate funding since Proposition 2 1/2 became effective. Since 1980, when pruning activity began to diminish, trees have had many years to grow beyond a safe level. Therefore GLORIA's high winds were hitting communities at a time when trees had become vulnerable because of five years of less than perfect

attention. Commonwealth employees and tree crews through the Bureau of Shade Tree Management and the University of Massachusetts Extension Service are available for field visits to towns to assist with tree condition assessment and to a limited degree with pruning activities. Unfortunately the six crews are not enough to adequately cover the state. A funding source is being pursued at the state level which would permit partial or total reimbursement to cities and towns for monies expended for pruning operations and tree work performed on public trees by private companies under the direction of local Shade Tree Wardens.

Metropolitan District Commission

Among its many duties, the MDC is responsible for the maintenance and operation of the Charles River Dam. The flood control structure mitigates flooding in the Charles River Basin area of Boston and Cambridge.

The MDC also provides flood mitigation benefits similar to those provided by Fisheries and Wildlife. The purchase of land for watershed protection has resulted in the preservation of floodplain along the Ware River and Charles River tributaries.

Department of Fisheries, Wildlife and Environmental Law Enforcement

Division of Fisheries and Wildlife

Neither the Department or Division has statutory responsibility for flood hazard mitigation. The authority of MGL Ch. 131, SS. 6-8 allows for the acquisition of land for the purpose of protecting any species of useful fish, birds or mammals, or for public fishing and shooting grounds. Many areas acquired for these purposes contain large acreages of flood plain which is retained in a natural state. This ensures that flood retention capabilities remain intact.

Executive Office Of Public Safety

Massachusetts Civil Defense Agency

Massachusetts General Law (Chapter 579, Acts of 1968) amended and defined the duties and function of the MCDA.

Chapter 579. AN ACT CLARIFYING AND ENLARGING THE SCOPE OF THE POWER OF CIVIL AUTHORITY UNDER EMERGENCY CONDITIONS ARISING OUT OF RIOTS OR OTHER CIVIL DISTURBANCES.

Be it enacted, etc., as follows:

SECTION 1. "Civil defense" shall mean the preparation for and the carrying out of all emergency functions, other than functions for which military forces other than the national guard are primarily responsible, for the purpose of minimizing and repairing injury and damage resulting from disasters caused by attack, sabotage or other hostile action; or by riot or other civil disturbance; or by fire, flood, earthquake or other natural causes. Said functions shall include specifically, but without limiting the generality of the foregoing, firefighting and police services other than the actual control or suppression of riot or other civil disturbance, medical and health services, rescue, engineering and air-raid warning services, evacuation of persons from stricken areas, emergency welfare services, communications, radiological, chemical and other special weapons of defense, emergency transportation, existing or properly assigned functions of plant protection, temporary restoration of public utility services and other functions;

Although the responsibilities of the MCDA are numerous, only duties during flood emergency will be considered in this report.

The Comprehensive Emergency Response Plan (CERP) prepared by MCDA states that the basic mission of the Agency is to prepare, warn, respond and recover. The Agency promotes preparation by encouraging disaster prevention or flood mitigation programs. These efforts may range from local zoning to structural solutions.

Initiation of alert procedures depend primarily on monitoring of National Weather Service reports. The procedure as stated in the CERP follows:

A. AGENCY TASK ASSIGNMENTS

I. General

a. Activities at the Direction of the Governor

Under provisions of the Civil Defense Act, the Governor may direct any agency of State government to prepare for and carry out a variety of disaster functions, including:

1. Those for which there is an obvious functional parallel (e.g. the Division of State Police with the Police and Security function).
2. Those for which agency resources are useful for various disaster response purposes (e.g. agency mobile radio cars for emergency communications).
3. General support of disaster response and preparedness operations (e.g. clerical support to agency representatives during disaster relief operations).

b. Agency Disaster Plans

Each State agency with disaster task assignments will develop and maintain an Agency Disaster Response Plan detailing agency organizational arrangements for emergency, specific emergency task assignments, and such special procedures for implementation as may be necessary.

c. Continuity of Activity

All State officials and agencies will provide for continuity of management and control of governmental activities, and of public services, during periods of emergency. If necessary, provision will be made for the conduct of such operations from the State and/or from an alternate State Emergency Operating Center (EOC).

d. Coordination with the Massachusetts Civil Defense Agency (MCDA)

Upon the request of the Director, MCDA, each agency with assigned emergency response functions will appoint personnel to provide liaison between MCDA at the Headquarters and Area level, and headquarters and district elements of the agency they represent. The authorities and responsibilities of such personnel will be set forth in the agency's Disaster Response Plan.

e. Assistance to Political Subdivisions

State agencies having emergency responsibilities will render direct assistance, in their areas of responsibility, to political subdivisions of the State, when so required by the situation and so requested by local authorities.

f. Mutual Emergency Field Support Plans

Those agencies having geographically decentralized operations (divisions, districts, local offices, etc.) will direct the supervisors in charge of such operations to develop mutual emergency field support plans in cooperation with MCDA Area personnel.

Division of Inspections

The Massachusetts State Building Code clearly outlines standards for construction in floodplains and coastal high hazard areas. According to Section 744.0, Design Requirements for Floodplains and Coastal High Hazard Areas, specific construction criteria are placed upon structures to be substantially improved or constructed within the 100 year floodplain and Coastal High Hazard Areas (see Appendix G). The objective of these criteria is to limit development which would incur substantial property damages in the event of a severe flood. Elevating structures, floodproofing electrical boxes, anchoring mobile homes and retaining records of floodproofing measures are all required elements of Section 744.0. Municipal building inspectors are responsible for ensuring compliance by property owners and builders. Typically building inspectors receive assistance from conservation commissions regarding flood zone determination, particularly if a property site is on a border between a

flood zone and an upland zone. Under the Flood Hazard Management Program Building Inspectors are visited periodically by the FHMP staff to discuss the level of floodplain encroachment in their community. At that time the FHMP staff person explains any changes in regulations which may effect the Building Inspector's duties. Additionally the FHMP staff reviews the Building Inspector/town floodplain management performance to determine if it complies with the expectations set forth through the National Flood Insurance Program. The Massachusetts Board of Building Regulations and Standards publishes a newsletter entitled Code Word which periodically discusses floodplain management issues. Massachusetts Building Inspectors also have conferences intended to inform and educate its participants. Floodplain management practices as they may apply to Building Inspectors are also discussed during conference workshops.

Executive Office Of Transportation And Construction

Department of Public Works

The Massachusetts Department of Public Works has no legislative responsibilities regarding the implementation of flood hazard mitigation programs. The department is, however, responsible for carrying out the policies of the Federal Highway Administration and meeting the requirements of M.G.L. Ch. 131, S. 40A. The MPDW is exempt from M.G.L. Ch. 130, S. 105.

The FHWA (Federal Highway Administration) policy toward floodplain management, implemented through DPW, is as follows:

- a. to encourage a broad and unified effort to prevent uneconomic, hazardous or incompatible use and development of the Nation's floodplains;

- b. to avoid longitudinal encroachments, where practicable;
- c. to avoid significant encroachments, where practicable;
- d. to minimize impacts of highway agency actions which adversely affect base floodplains;
- e. to restore and preserve the natural and beneficial floodplain values that are adversely impacted by highway agency actions;
- f. to avoid support of incompatible floodplain development;
- g. to be consistent with the intent of the standards and criteria of the National Flood Insurance Program, where appropriate; and
- h. to incorporate "A Unified National Program for Floodplain Management" of the Water Resources Council into FHWA procedures.

The FHWA and MDPW are also subject to E.O. 11988 which requires Federal executive agencies "to avoid, to the extent possible, the long-and-short term adverse impacts associated with the occupancy and modification of floodplains and to avoid the direct or indirect support of floodplain development whenever there is a practicable alternative." If the floodplain cannot be avoided, the agencies must minimize potential harm to people and property and to natural and beneficial floodplain values. To assure compliance, the order requires Federal and public review of proposed projects.

It should be noted that M.G.L. Ch. 131, S. 40 (the Wetlands Act) has had an impact on MDPW highway design. The requirement of providing compensatory flood storage for any flood storage lost within the 100-year floodplain has resulted in the design of flood detention basins as part of proposed quantity of flood water so that natural drainage courses are not subjected to flooding conditions any sooner than would occur previous to the construction of the highway.

Office Of The Lieutenant Governor

State Disaster Recovery Program

This program was instituted through the Lieutenant Governor's office in response to the 1978 Blizzard and was phased out in 1982. During its operation, many grants were handled through the Massachusetts Office of State Planning, the federal Department of Housing and Urban Development (HUD), and state Executive Office of Administration and Finance.

Assistance such as the "Unmet Needs Program" was provided with HUD funding in grant amounts up to \$10,000 to complement aid not available elsewhere. Grants for Floodproofing of structures was obtained by those eligible low income individuals. An effort was made to coordinate these activities with FEMA.

Records of many blizzard expenditures and community aid have been retained by this program. The primary function was one of coordination between various federal, state, and local authorities to ensure adequate response and follow-up of the '78 storm. In line with this role, the program, working with the Lieutenant Governor's Office and FEMA, developed a booklet entitled "A Coastal Homeowner's Guide to Floodproofing."

Executive Office Of Communities And Development

The Intergovernmental Review Monitor (Formerly A-95)

The Executive Office operates the State Clearinghouse through which federal agencies are required to submit plans for certain federally financed programs/projects. This function is a result of Presidential Executive Order 12372. Publication of the Massachusetts Intergovernmental

Review Monitor is designed to promote maximum coordination between federal, federal-assisted, state, areawide, and local programs. This clearinghouse is intended to provide a forum for federal, state, municipal, and private interests to review specific projects and to address potential conflicts.

Often project information submitted to the state clearinghouse may include only financial data, occasionally a brief written account of the project, and site map. However, the Clearinghouse will request additional data if a reviewer so desires.

Proposal files do not appear to be routinely examined by any government agency with the possible exception of the Massachusetts Historical Commission. As a result nearly all proposals are labeled as 'no conflict'. Federal agencies proposing backing of projects within floodplain areas do not usually publicly notify and provide information to the Clearinghouse as required by federal Executive Order 11988.

Department of Community Affairs

Under Communities and Development, a single existing development, that of Community Affairs (DCA), handles several forms of community assistance. The Division of Community Services and Community Development actually share these Department responsibilities.

Division of Community Services

The Division of Community Services furnishes both technical assistance to municipal governments and disaster response. The EOCD/DCS, as part of its legislative mandate under Chapter 23B of the General Laws, during

non-disaster times, can and does provide assistance to local governments of the Commonwealth in a variety of ways. This includes acting as liaison between federal, state and local agencies; planning and zoning; analyzing and helping solve municipal management and fiscal problems; grantsmanship; and dissemination of information.

Generally non-emergency technical assistance encompasses limited aid in dealing with zoning and land use problems for a specific area. The limitation in assistance is due to low staffing. An involved community usually will request such state input to clarify local responsibilities. Floodplain problems have not arisen in past cases handled. Model bylaws and ordinances were originally supplied through this office but that practice has been discontinued.

The General Laws mandate the keeping of a central file on all zoning regulations which the Division personnel have responsibility for maintaining. There can be up to a six month delay in updating such records due to town delays in forwarding new changes.

Workshops for Regional Planning Agencies and Massachusetts building officials are occasionally held by the Division's staff.

A Disaster Response Plan has been formulated by the Community Service staff. This report reviews response abilities and responsibilities to assist Civil Defense and the Office of Emergency Preparedness. In the event of a disaster, the DCS's initial area of assistance would be to notify local officials of the status of the situation, and where and how to request aid. The Local Liaison Section (LLS) of the Division has ongoing contracts and relationships with city and town officials. The LLS maintains an 800 TOLL-FREE telephone line on which local officials can call for assistance. The capacity of this service could be expanded with

additional lines, if needed. (This was done in response to the 1978 Blizzard Disaster). The toll-free number is presently well-known to officials, but in times of disaster, it could be publicized over an emergency broadcast system.

After the initial phase of a disaster has been handled, the DCS can help prepare and disseminate needed follow-up information to communities. The Division maintains computerized mailing lists of thousands of local officials that can be utilized. Another important function is to arrange the use of disaster processing centers to facilitate community applications for post-disaster federal assistance.

Division of Community Development

Through Community Development, assistance programs are provided to build, rehabilitate, modernize, and manage public housing under normal conditions. In the event of a disaster situation, this Division may also place victims in the few public housing units available. The majority of the displaced utilize rental assistance subsidies (Ch. 707) and are relocated in temporary quarters such as motels.

Public housing projects currently being developed fall under the Massachusetts Family Housing Program - Ch. 705, the state Handicapped Housing Program - Ch. 689 state Elderly Housing - Ch. 667, and HUD Section 8 funding.

These facilities are constructed and operated by Local Housing Authorities (LHA) which obtain funding and guidance from Community Development. The Department of Community Affairs selects which LHA will receive a Contract for Financial Assistance (CFA). Under the CFA, the community completes the initial planning and obtains local approvals. Then the Division's Bureau of Housing Development has the authority to review and

approve such planning including property selection, environmental assessments, and appraisals. The planning stage requires the completion of an Environmental Data Form (EDF) that questions placement within a floodplain and if so located requests boundary maps showing the 10, 15, 25, 50 or 100 year flood boundary. If significant environmental impact is likely then a more detailed EDF requests new and old contours displayed on a map with one foot intervals and also delineating finished floor elevations.

Under the Massachusetts Environmental Policy Act (MEPA-Ch. 301), certain DCA projects are excluded which involve not more than 200 residential units in a conversion/rehabilitation project where not more than 10% of new floor area is added, and those projects involving construction of not more than 100 new residential units without limitation as to cost. According to DCA if an EIR is required under MEPA, the Department will not fund the project due to the amount of time and money needed to complete such a report.

PRINCIPAL REGIONAL PROGRAM ACTIVITIES

Regional Planning Authorities (RPA).

Massachusetts has established Regional Planning Authorities in order to assist municipalities in a variety of ways including economic development, social services, environmental review and transportation planning. The RPA's have a water resources contact person at each agency. These individuals play varying roles in coordinating regional floodplain management issues. Appendix H contains the geographic boundaries of the RPA's.

PRINCIPAL LOCAL PROGRAM ACTIVITIES

Local government officials in Massachusetts have very active roles in floodplain management activities. These roles are best defined by the individual responsibilities each board, commission or department has in the permit system. The Conservation Commission has the most responsibility through its legislative mandate in environmental protection. Decision making will differ from town to town largely because of nontechnical, volunteer, part-time staffing; however, it does appear that floodplain management as it relates to environmental protection is being adequately addressed statewide, as a whole.

Two principal program activities appear to be lacking at the local level. One is the establishing and maintaining of data storage and retrieval systems. This is understandable since adequate funding, expert staffing and resource data collection do not often exist in communities. The other activity is coordinating local floodplain management efforts.

Conservation Commissions (MGLA Ch. 40, S. 8C)

Commissions have the authority to review proposals for projects in wetlands (Ch. 131, S. 40), assist in the drafting and enforcing of local floodplain and wetland by-laws and acquire land for open space and recreation purposes at the local level. Although water supply issues are addressed the most, protection from the hazards of floods by preservation of floodplains are included within a water management function. In a court decision (Turnpike Realty Company, Inc. vs. Town of Dedham, 362 Mass. 221, 1972), it has been shown there is a tendency to weight the petitioner's loss against the possible loss to the whole community. The Turnpike case gave approval to three basic public policy objectives: (1) protection of occupants of a floodplain, (2) protection of other

landowners from damages resulting from development of the floodplain, and (3) protection of the entire community from individual choices of land use which require subsequent public expenditures for public works or disaster relief.

The Act charges the commission to "... seek to organize the activities of unofficial bodies organized for similar purposes" so therefore a description of the Commissions' relations with other municipal bodies has been included in this section. By mid 1985, 334 of the 351 cities and towns in the Commonwealth had established their commissions. 138 had either full time or part time staff. 30 had full time or part time professional staff.

Commissions have three major roles in the mitigation of natural hazards. These roles are: (1) disseminating information on the NFIP and assisting FEMA to implement the program; (2) assisting in the interpretation and use of floodplain data; and (3) processing permits for private floodplain uses. They also play an active role in land acquisition primarily for recreational and open space purposes but not necessarily for floodplain management and hazard mitigation purposes.

Planning Board or Department (MGLA Ch. 41, S. 81).

Town Planning agencies have the responsibility for over-all municipal planning. Close coordination between the planning board and the Conservation Commission insures that the conservation, preservation and development of the municipality's natural resources are receiving adequate attention in the over-all planning process. In part, this can be accomplished through the commission's review of planning board rules and regulations, zoning bylaws, and filed development plans. Joint discussions on such matters as floodplain zoning, cluster zoning and responsibilities under the Wetlands Protection Act are also important.

The Boards conduct two principal program activities in floodplain management: (1) mapping the community's floodplain and (2) monitoring floodplain development. More indirectly, a Board may also disseminate information on the NFIP and process permits for private floodplain uses while administering a subdivision control law (MGLA CH. 41, SS. 81K-81GG).

Board of Health and/or Sewer Commission (Title 5).

Boards of Health and Sewer Commission control such vital aspects of land use planning as disposal of sanitary wastes in non-sewered areas and maintenance of sewers. The Conservation Commission can urge the Board to adopt stiffer local health regulations on building in floodplains which can supplement floodplain zoning. Their part in reviewing and regulating public sewer use is a principal program activity which may have an influence on whether growth is encouraged in hazard-prone areas.

Building Inspector or Zoning Administrator.

Building Inspectors are responsible to the selectmen or mayor, and have the primary job of assuring that all local projects are in conformity with the zoning ordinance or bylaw, including municipal floodplain or wetlands protection zoning. Under S. 108.1 of the state building code, the building inspector may enforce any state statutes, rules, regulations, ordinances and bylaws and act on any question relative to the location of buildings and structures. Good relations between the Conservation Commission and the building inspector can therefore assure that building permits will not be handed out for construction in possible wetland areas without notice to the commission.

In summary, distributing Flood Insurance Rate Maps and processing permits for private floodplain uses are the inspectors principal program

contributions regarding floodplain management activities. The inspector should also be able to assist in the interpretation and use of floodplain data.

Zoning Board of Appeals (ZBA).

A town ZBA acts more like a court than an administrative body. It guards the zoning ordinances or bylaw by hearing appeals from orders of the building inspector and others and gives flexibility by granting special permits and variances where a zoning bylaw authorizes them, and by granting variances in hardship cases. A commission member should attend hearings by the board relating to variances and special permits in floodplain or wetlands protection zoning districts and state whether the commission agrees with or objects to the proposed action.

PRINCIPAL FEDERAL PROGRAM ACTIVITIES

The Federal Emergency Management Agency

The National Flood Insurance Program (NFIP)

The NFIP was established by Congress in 1968. The program provides subsidized flood insurance to property owners in participating communities. To qualify, local governments must adopt and enforce minimum floodplain management regulations in accordance with FEMA regulations and guidelines.

Pursuant to the Flood Disaster Protection Act of 1973, any federal financial assistance related to new construction or substantial (greater than 50%) improvements of existing structures located in the 100-year floodplain is contingent on the purchase of flood insurance. Such federal assistance includes not only direct aid from agencies, but also from federally insured savings and loan institutions. Thus, in order for property owners to be eligible for purchasing flood insurance, their respective community must be participating in the NFIP and in compliance with NFIP guidelines. In Massachusetts, 320 out of 351 communities participate in the NFIP. 78 of the 320 participating communities are within the Massachusetts Coastal Zone.

1362 Program

Section 1362 of the National Flood Insurance Act allows FEMA to purchase property from willing sellers where insured buildings have been damaged more than 50% in a single storm or at least 25% in three storms over a five year period. The acquisition of 18 properties through the use of 1362 funds was achieved in the Towns of Scituate and Hull following the 1978 Blizzard.

Communities Assistance Program (CAP)

This program provides funding to the State Department of Environmental Management-Division of Water Resources, Flood Hazard Management Program for technical staff to assist and assess community floodplain management officials.

Executive Order 11988

The objective of E.O. 11988 is "... to avoid to the extent possible the long-and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative ...". This Order applies to all federal agencies that:

- 1) acquire, manage, or dispose of Federal lands and facilities;
- 2) undertake finance, or assist construction and improvements; and
- 3) conduct activities and programs affecting land use, including planning, regulating, and licensing.

The U.S. Army Corps of Engineers

Continuing Authorities Program

Congress had delegated responsibility to the Secretary of the Army to plan design and construct certain projects without the specific authorization of Congress. Formerly referred to as the "small projects program, the Continuing Authorities Program is designed to provide a timely response to limited flood, navigation and erosion problems.

Presently the New England Division (NED) of the Corps has a number of projects which fall under this program. Among the presently active projects are:

Flood Damage Reduction

POINT OF PINES - Final plans and specifications have been prepared for a \$4.4 million rock revetment, concrete wall and sand dune project to protect the area from flooding.

WEST SPRINGFIELD - New England Division will begin the preparation of plans and specifications this fiscal year to expand the pumping and gravity outflow capacity at the Riverdale pumping station. The pumping station is part of the Riverdale Local Flood Protection Project built by the Corps in 1950 along the west bank of the Connecticut River in West Springfield.

SPRINGFIELD - An appraisal of the need for modifications to the existing local protection project along the Connecticut River in Springfield is complete. The report concluded that local flood protection would be increased by raising the concrete floodwall portions of the project. The Mayor of Springfield has requested a reconnaissance report to determine the feasibility of the modification. The study began in October 1986.

Streambanks and Shoreline Protection

SHEFFIELD - Action is being taken to correct a streambank erosion problem at a covered bridge on the Housatonic River. A construction contract was awarded in September in the amount of \$345,675. Construction of the riprap stone protection began in October 1986 and is scheduled for completion in the spring of 1987.

CONWAY - Construction of emergency streambank protection along two sections of the South River has begun. The plan, which provides for placement of 650 linear feet of stone slope protection, will protect State Route 116. Completion is scheduled for March 1987.

COLRAIN AND ASHFIELD - Detailed studies have been initiated under Section 14 authority to determine the need for erosion control along the North and South rivers in Colrain and Ashfield, respectively. Efforts are being coordinated with the Massachusetts Department of Public Works.

Navigation

ROCKPORT HARBOR - The small navigation improvement project at Rockport was authorized for construction funding, and a \$811,000 contract was awarded on May 15, 1986. The project provides for the dredging of entrance channels and protected anchorage areas in Rockport Harbor and Pigeon Cove. The dredging began in October 1986 and is scheduled to be completed by March 1987.

PINES RIVER - Public comments on a draft detailed project report which recommends federal participation in channel and anchorage improvements in the Pines River in Revere and Saugus are being reviewed. Upon completion of our review and coordination with appropriate state.

NANTUCKET HARBOR - Preliminary finding indicate that federal participation in channel and anchorage improvements at Nantucket Inner Harbor and Polpis Harbor appear justified. A reconnaissance phase study has begun and hydrographic surveys are underway.

NASKETUCKET BAY - An Initial Appraisal Report, including a recommendation for further study of this mixed use (commercial and recreational) harbor in Fairhaven, was approved by Washington in September, 1986. A reconnaissance study is underway.

SAUGUS RIVER - A detailed project study of the need for federal participation in channel and anchorage improvements in the Saugus River in Saugus and Lynn is continuing. The study is being coordinated with municipal plans for development of the river. A draft report was distributed for public review in October 1986.

Beach Erosion Control

YARMOUTH - A detailed project report on Seaview and Parkers River beaches (located eastward of the mouth of the Parkers River) was approved by Washington in July 1985 under the Section 103 small beach erosion control projects program. The project entails widening 1,400 feet of beach by the placement of sandfill to provide a 50-foot-wide beach berm above mean high water. Six existing groins would also be rehabilitated to stabilize retention of the sandfill.

Specific Authorization Projects

Any Federal project which is not subject to the Continuing Authority Program must have specific authorization from Congress. All projects begin with a study and report on the need and justification for the work as well as assurances of cooperation from the State and/or municipalities that are affected. Funds for implementation of the work are not included in the authorizing act and must be allocated in subsequent congressional appropriations.

Presently the Corps NED has the following specifically authorized projects actively underway:

Flood Damage Reduction

REVERE, LYNN, SAUGUS and MALDEN - Flood damage reduction studies have been completed for the Roughans Point and Point of Pines areas of Revere and are in progress for the Saugus River and tributary areas of Revere and nearby communities of Lynn, Malden and Saugus. These neighborhoods suffered major damage from coastal flooding during the February 1978 blizzard.

Recommendations for Roughans Point, approved by the Board of Engineers for Rivers and Harbors in December 1983, include measures to stabilize existing flood control structures and reduce wave runup. The estimated cost is \$9.2 million. Project planning and engineering is continuing with tidal hydrology studies and preparation of design memoranda. The project was authorized for construction by the Water Resources Development Act of 1986. Project implementation is dependent upon future congressional appropriation.

At Point of Pines, the final plans and specifications for a \$4.4 million rock revetment, concrete wall and sand dune project to protect the area from coastal flooding will be reviewed by the Assistant Secretary of the Army (Civil Works) prior to approval for construction.

The Saugus River and Tributaries (formerly the Revere Beach Backshore) study is considering improvements to reduce coastal flood damage to developed areas behind Revere Beach and the area

east of North Gate Shopping Center in Revere and in the adjacent cities of Lynn and Malden and the town of Saugus. One option is to provide floodgates on the Saugus River and shorefront protection along Revere Beach and Lynn Harbor to reduce flooding in the four communities.

The congressionally authorized Revere Beach erosion control project would restore 13,000 feet of beach and reduce maintenance costs of existing facilities and seawalls by \$22.6 million over the project life. The estimated first cost of the project is \$6.9 million. Completion of design and initiation of construction is contingent upon the execution of a formal Local Cooperation Agreement (LCA) that will set forth the terms of local cost sharing (36 percent) for the project.

TOWN BROOK - The recent passage of H.R. 6 by Congress (the Water Resources Development Act of 1986) authorized a \$26.5 million flood protection plan for Braintree and Quincy. Flood control measures include a deep rock relief tunnel 4,060 feet long and 12 feet in diameter and modification to an existing upstream reservoir and dam. This plan is part of an overall flood control system for Braintree and Quincy. Preconstruction planning and engineering, including cost updates for the project, are continuing. All project feature design memoranda are scheduled for completion by December 1986. Planning is being closely coordinated with projects under development by the Metropolitan District Commission and the Massachusetts Bay Transportation Authority. Funds have been appropriated by Congress for the current year to begin project construction. Prior to that, a formal Local Cooperation Agreement (LCA) must be executed with the project sponsor (MDC) for the 25 percent local cost sharing.

WESTFIELD RIVER BASIN - As a result of regional flooding that accompanied heavy rains in late May and early June 1984, the flood control potential and other allied water related uses of the Westfield River Basin are being reevaluated under the regional plan developed by the Connecticut River Basin Comprehensive Study. Original emphasis on finding additional storage to compensate for Knightville Reservoir's limitations has been expanded to include re-investigation of Westfield local flood protection measures.

Navigation

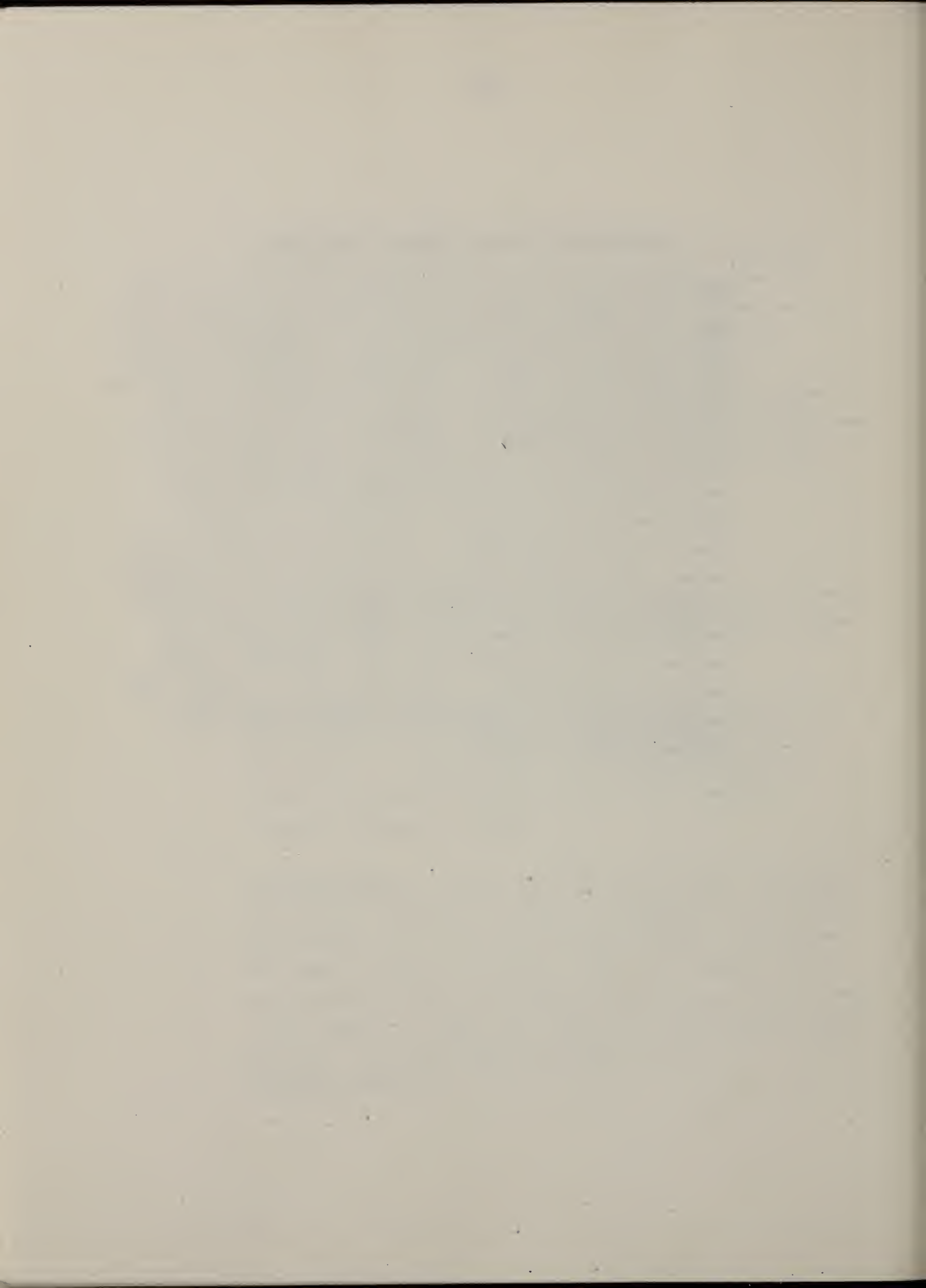
CAPE COD CANAL - Dredging of several shoal areas within the Canal was accomplished during October by the government hopper dredge MCFARLAND.

BOSTON HARBOR - Deepening of the various federal channels is being examined as part of our deep-draft navigation study of Boston Harbor. Initial benefit-to-cost analysis indicates further study of the deepening of the harbor's commercial navigation channels is needed.

GLOUCESTER HARBOR - A draft detailed project report concerning the need for channel and anchorage improvements in Smith Cove, off the east side of the Gloucester Inner Harbor, is scheduled for public review in the spring of 1987. The proposed project would provide an eight-foot-deep, 60-foot-wide and 750-foot-long access channel to a three-acre, eight-foot-deep anchorage within the cove. The project has an estimated cost of \$500,000-1,000,000.

Conservation and Environmental Enhancement

HODES VILLAGE DAM - A draft Environmental Impact Statement (EIS) was issued in March 1984 on a plan to modify the operation of the federal flood control dam in Oxford, Mass., to provide low river flow augmentation to improve water quality in the French River in Massachusetts and Connecticut. Low flow augmentation is one element of a plan developed by the Corps at the request of the U.S. Environmental Protection Agency (EPA) and the states of Massachusetts and Connecticut. Modification of the existing project would entail the removal of vegetation and organic topsoil so that seasonal water storage could be impounded behind the dam. Other elements under consideration by EPA are advanced wastewater treatment in Webster and Dudley, Mass., and sediment deactivation in impoundments downstream of the dam. EPA has prepared a Final Supplemental EIS to the Corps' EIS to address issues concerning the entire French River cleanup program. The New England Division furnished review comments on the Final Supplemental EIS in July 1986.



CHAPTER V

RELATIONSHIP BETWEEN EXISTING MEASURES AND DAMAGES

Through the many existing hazard mitigation measures discussed in the previous chapter it is clear that the Commonwealth has some effective policies in place which can reduce the amount of property damage and bodily harm during a disaster. Inland and coastal floodplain management are probably some of the most successful of these measures. Unfortunately as stated in Chapter III high winds were the most destructive force delivered by GLORIA and not flooding problems. Except in a few cases GLORIA did not "put to the test" all the floodplain and wetland management practices the Commonwealth has implemented since 1978 when Massachusetts was so severely struck by the Blizzard of '78. To answer the question the title of this section suggests it can be said there is little correlation "between existing measures and damages". It can also be said that for a high wind hazard hurricane like GLORIA there are few reasonable wind-damage protection measures which exist that could mitigate damages.

The communities which were most severely "put to the test" by GLORIA are located in the southwest corner of the state where the greatest amount of rainfall occurred. Many communities received six inches of rain on September 27, 1985. This report looks closely at flood mitigation practices for sixteen of these communities which represent those towns that received five inches of rain or more during September 27, 1986.

Table 12 presents information about each of the community's flood mitigation practices such as their participation in the National Flood Insurance Program and any dams they may have.

Table 12. Selected Community Review

Community	Date entered NFIP	Emergency or Regular Phase	Number of Dams	Number of Dams For Flood Control	Town Has Conservation Commission
Becket	3-8-77	E	4		yes
Blandford	NP		2		yes
Chester	12-18-84	E	2		yes
Cummington	6-2-75	E	0		yes
Goshen	10-17-78	R	3		yes
Granville	NP		4	1	yes
Hunington	7-9-75	E	3	1	yes
Middlefield	NP		2	1	yes
Montgomery	NP		0		yes
Otis	12-15-83	R	1		yes
Peru	NP		1		yes
Russell	8-8-75	E	9	4	yes
Sandisfield	12-4-84	R	5	1	yes
Tolland	NP		0		no
Westhampton	7-2-79	R	2		yes
Worthington	7-23-75	E	0		yes
Total:			38	8	

The information from Table 12 suggests that those towns which received heavy rainfall did have in place flood mitigation measures. More of the towns could be involved with the National Flood Insurance Program (NFIP) if they had adopted appropriate floodplain management measures earlier. Generally speaking the priority communities the Federal Emergency Management (FEMA) agency works with to become participating communities with the NFIP are coastal, high growth and densely populated communities such as those around Boston and Route 495. The listed sixteen communities do not fit any of the early participant categories. Therefore it is understandable that a smaller percentage of participating communities exist in this western area of the state (54%) than in the state in general (91%). There are fewer homes in the 100 year floodplain in this area than elsewhere in the state. Eventually those communities not participating in the NFIP will be participating following the adoption by the community of more precise floodplain management by-laws.

According to a U.S. Army Corp of Engineers report entitled Inventory of Dams in the United States a minimum of forty-three dams are identified in the seventeen town area. Based upon review of this report by knowledgeable personnel it is felt that these towns have additional dams which are not identified in the report. The report indicates that the primary purposes of the dams include irrigation, flood control, water supply, debris control, hydroelectric, navigation, recreation and other. According to the report eight (8) of the dams are for flood control. Whether or not a dam is specifically categorized as a flood control structure it serves a flood water storage purpose, if only to detain water from passing along its watercourse. The Farmington and Westfield River basins and their tributaries were subject to less flooding because of the existence of these structures.

Under the Massachusetts Wetlands Protection Act local Conservation Commissions are responsible for administering the Act. In Massachusetts almost all of the municipalities have Conservation Commissions. Of the sixteen high rainfall communities only one, Tolland, does not currently have an operating commission. The communities which don't have commissions tend to be those with minimal wetlands, low populations and minimal municipal staff to push forward the establishment of a commission.

The Lower Pioneer Valley Regional Planning Commission developed a booklet entitled Planning for Floods, A Guide For Action in the Pioneer Valley (22 pages). This is used as a tool to assist communities with their floodplain management. The Commission also has a designated individual who works on floodplain management issues with communities. The Berkshire County Regional Planning Commission plays an active role in assisting communities to adopt appropriate by-laws to become participants in the NFIP. According to the Commission's staff their most important role is to advocate the adoption of more restrictive by-laws than those minimally required to participate in the NFIP. Since the Federal Emergency Management Agency staff and the Flood Hazard Management Program staff already work with by-law adoption the commission staff feels that it would be redundant to provide the same assistance and, instead, they should provide a service above and beyond what is already available.

Recently under the Massachusetts Scenic Rivers Program, an 18 mile corridor along the Farmington River which passes between Sandisfield and Tolland was classified a Recreational Natural Landscape under the Massachusetts Scenic and Recreational Rivers Program. As discussed in chapter IV the beneficial floodplain management policies established by this classification are significant particularly under potential flash flooding conditions such as were presented by GLORIA.

In an effort to learn as much as possible about how government agencies address natural hazard risks a questionnaire was distributed after Hurricane Gloria (Appendices I and J). The questionnaire was designed to determine if the agency operates under any flood mitigation guidelines, how it responds to a flood emergency and what follow-up study or documentation may occur. Fifty (50) questionnaires were mailed in April, 1986 to Emergency Liason & Planning Officers designated by the Massachusetts Civil Defense Agency. Twenty-two (22) of the questionnaires were completed and returned. The twenty-two responses were organized into 3 categories. These categories and information about any plan they may have is contained in Table 13.

Table 13. Questionnaire Results

	With Plan		No Plan
	Written	Not written	
Agencies considered primary responders to disaster events	8	2	3
Natural resource management/monitoring agencies	2	1	4
miscellaneous affiliated agencies		1	1
Totals	10	4	8

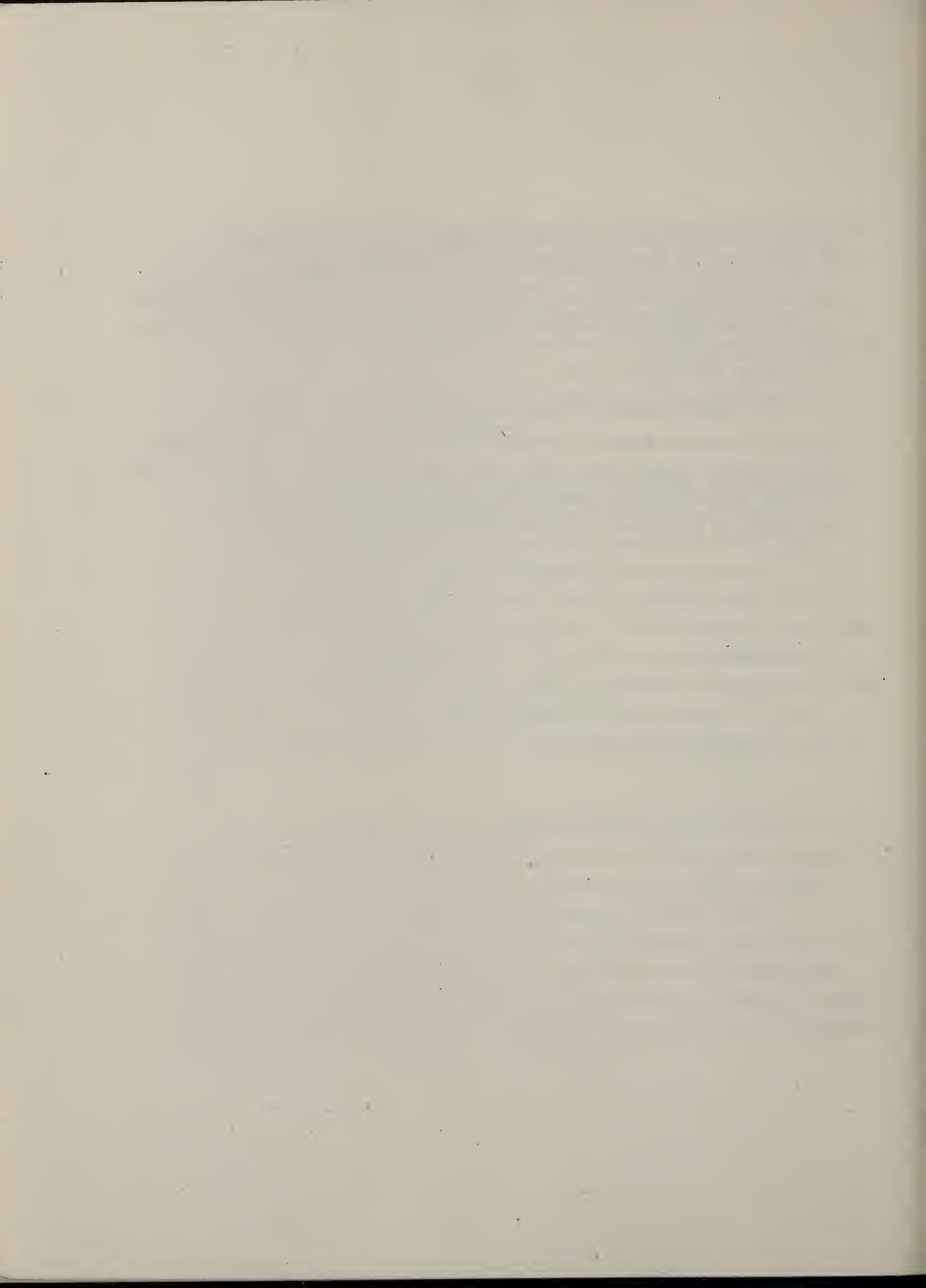
The questions on the hazard Mitigation Questionnaire were chosen to indicate the extent agencies have a planned approach for contending with disaster mitigation and disaster response. Much of the purpose of the questions was to obtain generalized information and agency contacts. It must be understood that a quantitative scientific survey was not conducted but rather a simple questionnaire with obvious limitations such as the pool of addresses used for mailing, the sampling of responders and the qualitative nature of the questions.

Since the Emergency Liaison and Planning Officers mailing list was used for distribution and because of the role the Officers play in disasters it was likely that there would be a large portion of "event response" or preparedness agencies completing the questionnaire. For these agencies a major portion of their work is concerned with public safety and response to emergency conditions. It is therefore likely these agencies would have a disaster plan. The natural resource management agencies have many responsibilities other than hazard mitigation and would therefore be less likely to have a disaster plan in place. It was encouraging to learn that many non - response related agencies did have plans.

The questionnaire responses suggest that many agencies such as the State Police, Massachusetts Turnpike Authority and The Adjutant General's Office are established specifically for the purpose of public safety. Because their primary duties demand attention to public safety preparedness and response these agencies may not appear to have the time to address flood mitigation practices. Although floodplain management planning and the delivery of public safety services are connected through a cause and effect relationship, the types of problem solving challenges

professionals and staff in these two fields encounter are vastly different. It is likely therefore that the response agencies would not actively develop flood hazard mitigation plans. Likewise natural resource planning and regulatory agencies may not be fully aware of the activities of response agencies.

The questionnaires returned collectively suggest that plans of action by response agencies seem to be in place but that true mitigation plans from any type of agency are not common. It must be stated that some agencies may not have a formal mitigation plan but do have policy statements or guidelines which do address hazard mitigation.



CHAPTER VI

IMPLEMENTATION MEASURES

(Recommended Hazard Mitigation Measures)



FLOOD HAZARD IMPLEMENTATION MEASURES

<u>TASK</u>	<u>LEAD AGENCY*</u>	<u>IMPLEMENTATION SCHEDULE</u>	<u>FUNDING</u>	<u>LOCAL ACTION REQUESTED</u>	<u>MONITORING</u>	<u>COMMENTS</u>
1. <u>Draft legislation to establish a Bureau of Floodplain Management</u>	DEM	FY 88	Regular Program Implementation	No	DEM staff to identify legislative sponsor	A need exists for the Commonwealth to coordinate floodplain management activities among the various state agencies.
2. <u>Draft legislation for the acquisition of storm damaged property</u>	MCZM	FY 87	Regular Program Implementation	No	MCZM staff to identify legislative sponsor	Similar to Section 1362 of FIA, a State acquisition program provides a strong non-structural incentive to remove development from floodplains.
3. <u>Draft Coastal Hazards Executive Order</u>	MCZM	FY 88	Regular Program Implementation	No	Coordinate with Governor's Office	E.O. will provide Policy guidance to State agency's involved with activities effecting coastal floodplains.
4. <u>Establish computer assisted floodplain management reference facility and clearinghouse</u>	DEM; DWR	FY 90	Requires Department budget request (\$150,000.00)	Coordinate with local officials	Continuing update of files and maps	Provides update on floodplain conditions, policies and activities.
5. <u>Revise and strengthen Wetlands Protection Act Coastal Regulations (i.e. establish performance standards for Land Subject to Coastal Storm Flowage)</u>	DEQE; DWR	FY 88	Regular Program Implementation	Public Hearings	-	Clearly define standards for development in coastal hazard areas.
6. <u>Draft legislation to establish a beach restoration program</u>	MCZM	FY 88	Regular Program Implementation	No	MCZM staff to identify legislative sponsor	Provides non-structural alternative to reduce coastal storm damage.

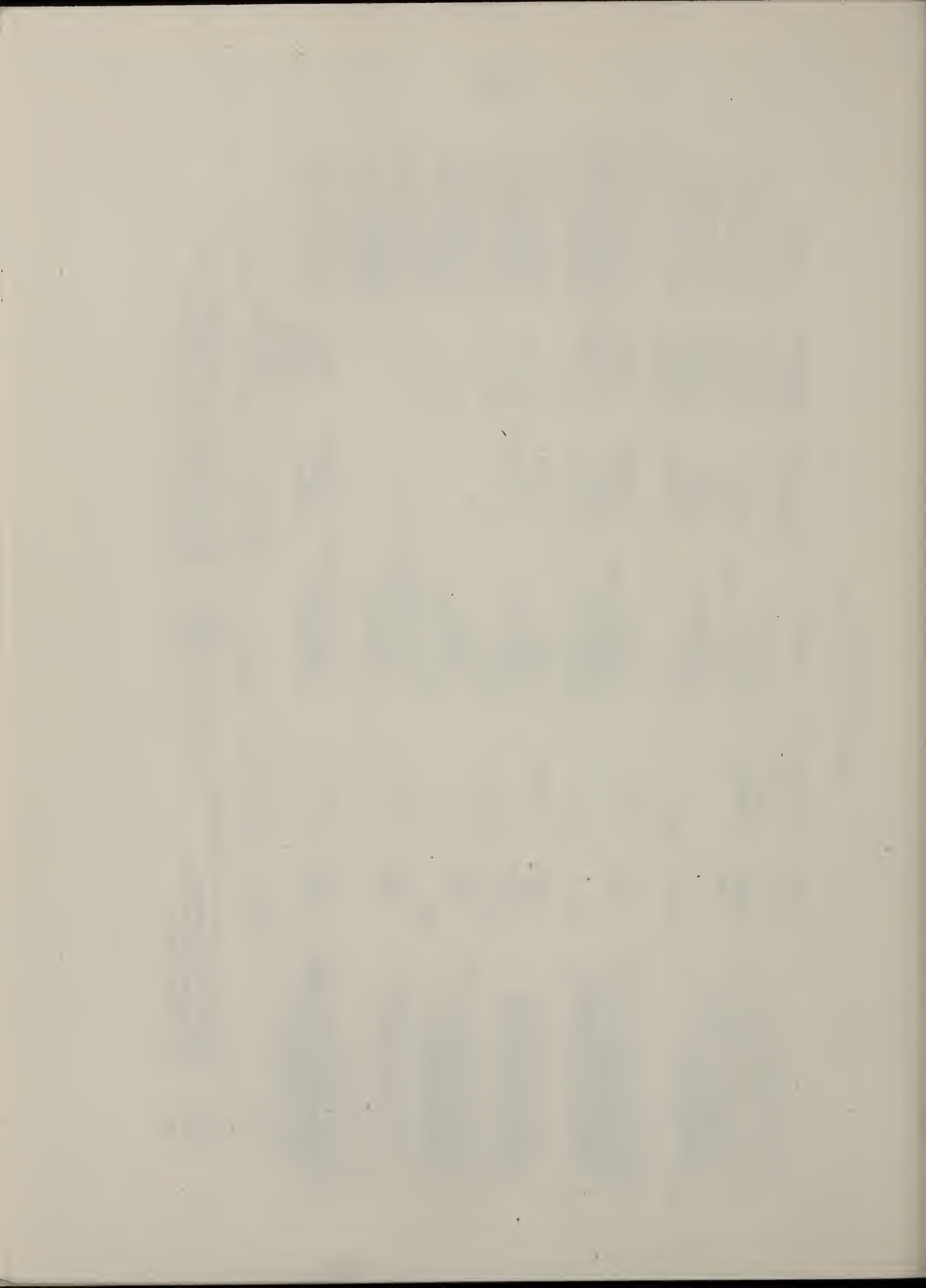
FLOOD HAZARD
IMPLEMENTATION MEASURES

<u>TASK</u>	<u>LEAD AGENCY*</u>	<u>IMPLEMENTATION SCHEDULE</u>	<u>FUNDING</u>	<u>LOCAL ACTION REQUESTED</u>	<u>MONITORING</u>	<u>COMMENTS</u>
7. <u>Complete transfer of administrative authority for Wetlands Restriction Program from DEM to DEQE</u>	DEQE	FY 88	None required	No	-	Although the program budget was transferred in 1983 to DEQE, the legal authority remains with DEM which complicates restriction process.
8. <u>Establish a Task Force to investigate the feasibility and effectiveness of a statewide flood warning system</u>	DEM; DWR	FY 89	Requires Department budget request (\$35,000.00)	No	Task Force scopes and oversees study	A statewide flood warning system could better coordinate emergency response/preparedness.
9. <u>Establish state policy regarding sea level rise</u>	MCZM/ DEQE	On-going FY 88	Regular Program Implementation	No	Requires informational meetings with agency staffs	Concerns about future SLR and its implications for flooding & storm damage must be addressed.
10. <u>Increase level of contact with communities containing Scenic Rivers to develop Scenic Rivers by-laws which promote natural valley storage</u>	DEM; SRP	FY 89	Regular Program Implementation	Participation of local officials	Provide draft by-laws	Raise level of awareness for flood storage capacity of rivers.
11. <u>Draft erosion rate set-back ordinance for local officials</u>	MCZM	FY 88	Regular Program Implementation	Coordinate with local officials	Encourage adoption by towns	Local officials can adopt more stringent by-laws that govern building in hazardous areas.
12. <u>Review MCZMP's policy's concerning coastal hazards & floodplain management</u>	MCZM	On-going FY 88	Regular Program Implementation	No	Requires informational meetings with affected agencies	Provides improved language and strong statement of policy in CZM Program.

FLOOD HAZARD IMPLEMENTATION MEASURES

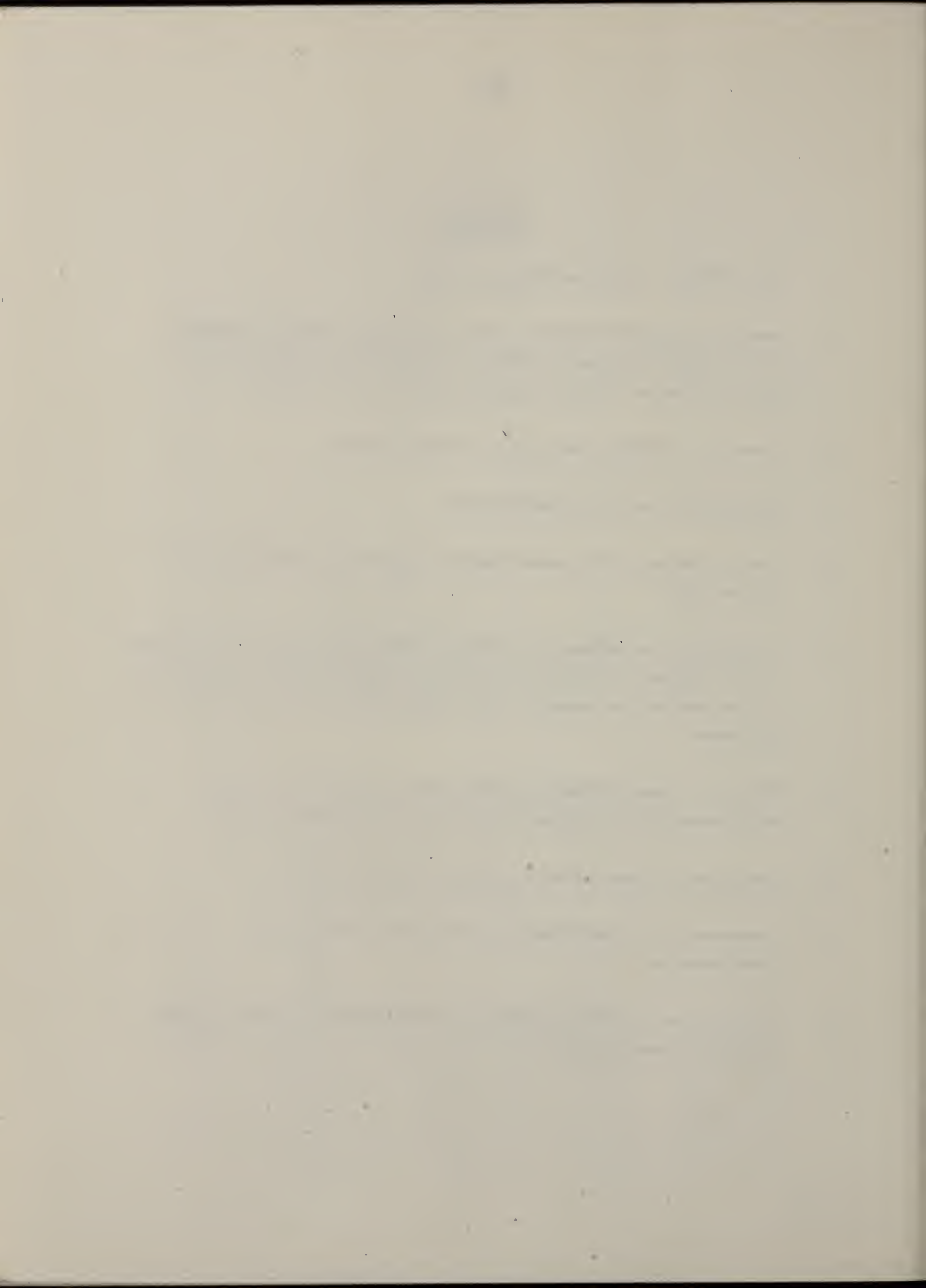
<u>TASK</u>	<u>LEAD AGENCY*</u>	<u>IMPLEMENTATION SCHEDULE</u>	<u>FUNDING</u>	<u>LOCAL ACTION REQUESTED</u>	<u>MONITORING</u>	<u>COMMENTS</u>
13. <u>Develop technical specifications and guidelines for on-site sewage disposal systems in flood hazard areas</u>	DEM; FHMP	FY 89	Requires Department budget request (\$35,000.00)	Input from local boards	Oversee contract; distribute references to state and local officials	Provides design criteria for on-site systems in flood hazard areas.
14. <u>Conduct a ten year assessment of the 1978 Blizzard. Review of preparedness plans for five most damaged communities</u>	DEM/ MCZM	FY 88	Requires Department budget request (\$10,000.00)	Coordinate with local officials	Provides local officials with assessment report	An assessment would provide evaluation of actions and/or improvements to local pre-storm hazard planning.
15. <u>Provide hazard mitigation educational programs for local officials and general public</u>	MCZM/ DEM/ DEQE	On-going	Regular Program Implementation	Request local participation	-	Provide slide shows, technical workshops and printed material to public.
16. <u>Encourage coordination between town Open Space Plan objectives and funding selection criteria</u>	DCS/ FHMP	FY 87	Regular Program Implementation	No	-	Place higher priority for acquisition/preservation of flood-plains.
17. <u>Establish yearly community assistance visits program</u>	DEM; FHMP	FY 89	Requires Department budget requests (\$57,000.00)	No	-	Visits would provide assistance and evaluation to communities.
18. <u>Conduct community assistance visits with those 3 communities which received the greatest rainfall during Gloria</u>	DEM; FHMP	FY 88	Requires Department budget request (\$2,700.00)	Participation of local officials	Provide evaluation and recommendation report to local officials	-

* DEM = Department of Environmental Management
 DWR = Division of Water Resources
 FHMP = Flood Hazard Mitigation Project
 SRP = Scenic Rivers Program
 MCZM = Massachusetts Coastal Zone Management
 DEQE = Department of Environmental Quality Engineering
 DWWR = Division of Wetlands/Waterways Regulation
 DCS = Division of Conservation Services



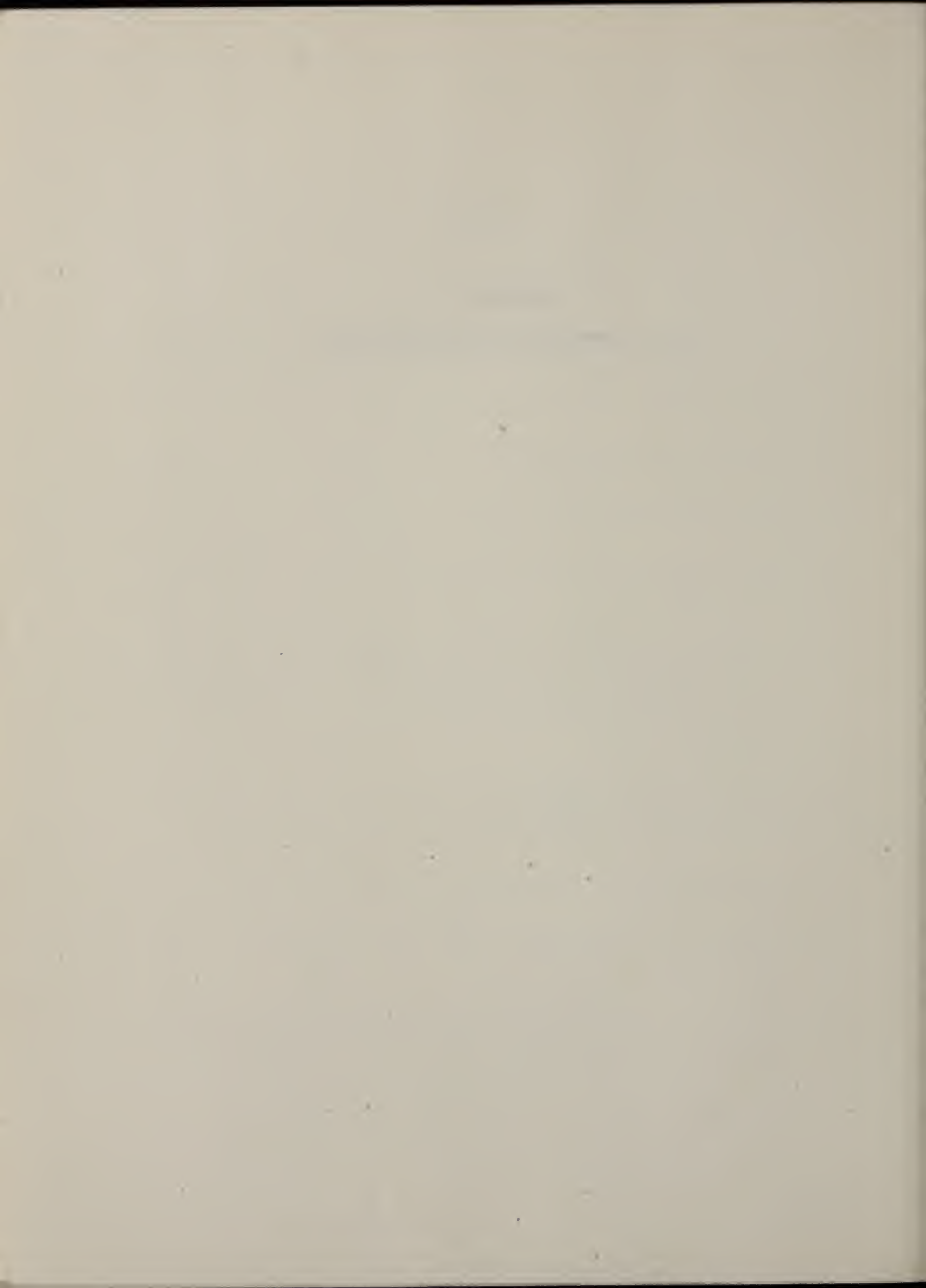
APPENDICES

- A. Safir/Simpson Hurricane Catagory Scale
- B. Report on Atlantic Tropical Cyclone "Hurricane GLORIA" September 17-27, 1985. Prepared by Robert B. Rice, Director of Special Projects Weather Services Corporation October 15, 1985.
- C. Inventory of Historical Storms in Massachusetts.
- D. Earthquake History of Massachusetts.
- E. Federal Emergency Management Agency Disbursement Summary Report: October 1986
- F. A Report on the Assessment of Flood Damages Resulting from the Storm of 6-7 February 1978 Along the Coastline from Orleans, Massachusetts to New Castle, New Hampshire, New England Division, Corps of Engineers.
- G. 780 CRM: State Building Code Commission Section 744.0 Design Requirements for Floodplains and Coastal High Hazard Areas.
- H. Boundaries of Massachusetts Regional Planning Agencies.
- I. Commonwealth of Massachusetts Natural Hazard Mitigation Questionnaire.
- J. Cover Letter for the Commonwealth of Massachusetts Natural Hazards Mitigation Questionnaire.



APPENDIX A

Safir/Simpson Hurricane Catagory Scale



CATEGORY 1 — Winds of 74-95 miles per hour. Damage primarily to shrubbery, trees, foliage, and unanchored mobile homes. No real damage to other structures. Some damage to poorly constructed signs. And/or: storm surge 4 to 5 feet above normal. Low-lying coastal roads inundated, minor pier damage, some small craft in exposed anchorages torn from moorings.

CATEGORY 2 — Winds of 96 to 110 miles per hour. Considerable damage to shrubbery and tree foliage; some trees blown down. Major damage to exposed mobile homes. Extensive damage to poorly constructed signs. Some damage to roofing materials of buildings; some window and door damage. No major damage to buildings. And/or: storm surge 6 to 8 feet above normal. Coastal roads and low-lying escape routes inland cut by rising water two to four hours before arrival of hurricane center. Considerable damage to piers. Marinas flooded. Small craft in unprotected anchorages torn from moorings. Evacuation of some shoreline residences and low-lying island areas required.

CATEGORY 3 — Winds of 111 to 130 miles per hour. Foliage torn from trees; large trees blown down. Practically all poorly constructed signs blown down. Some damage to roofing materials of buildings; some window and door damage. Some structural damage to small buildings. Mobile homes destroyed. And/or: storm surge 9 to 12 feet above normal. Serious flooding at coast and many smaller structures near coast destroyed; larger structures near coast damaged by battering waves and floating debris. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Flat terrain 5 feet or less above sea level flooded inland 8 miles or more. Evacuation of low-lying residences within several blocks of shoreline possibly required.

CATEGORY 4 — Winds 131 to 155 miles per hour. Shrubs and trees blown down; all signs down. Extensive damage to roofing materials, windows and doors. Complete failure of roofs on many small residences. Complete destruction of mobile homes. And/or storm surge 13 to 18 feet above normal. Flat terrain 10 feet or less above sea level flooded inland as far as 6 miles. Major damage to lower floors of structures near shore due to flooding and battering by waves and floating debris. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Major erosion of beaches. Massive evacuation of all residences within 500 yards of shore possibly required, and of single story residences on low ground within 2 miles of shore.

CATEGORY 5 — Winds greater than 155 miles per hour. Shrubs and trees blown down; considerable damage to roofs of buildings; all signs down. Very severe and extensive damage to windows and doors. Complete failure of roofs on many residences and industrial buildings. Extensive shattering of glass in windows and doors. Some complete building failures. Small buildings overturned or blown away. Complete destruction of mobile homes. And/or: storm surge greater than 18 feet above normal. Major damage to lower floors of all structures less than 15 feet above sea level within 500 yards of shore. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Massive evacuation of residential areas on low ground within 5 to 10 miles of shore possibly required.

To relate hurricane intensity to damage potential, the National Hurricane Center uses the Saffir/Simpson scale which assigns storms to five categories. Category One is a minimum hurricane; Category Five is the worst case.

APPENDIX B

Report on Atlantic Tropical Cyclone "Hurricane Gloria," September 17-27
1985. Prepared by Robert B. Rice, Director of Special Projects Weather
Service Corporation, October 15, 1985.





WEATHER SERVICES CORPORATION

WSC

R E P O R T
ON
ATLANTIC TROPICAL CYCLONE
Hurricane "Gloria"
September 17 through 27, 1985

PREPARED BY: Robert B. Rice
Director of Special Projects

October 15, 1985

"GLORIA"; SEPTEMBER 17-27, 1985

Hurricane Gloria was a "classic" Atlantic tropical cyclone. She was born in the midst of a tropical wave that had moved to sea through the Cape Verde islands after having traversed the continent of Africa. Following the textbook life history of the tropical cyclone, she then moved westward while passing through the stages of tropical wave to tropical depression to tropical storm. She then achieved her hurricane ranking during the morning of September 22nd while bearing down on the Leeward Islands, part of the chain of islands separating the Atlantic Ocean from the Caribbean Sea and still some 1900 miles and five days from its final landfall over Long Island, New York.

Hurricanes can be classified in various ways. In meteorological terms, those of central pressure and maximum wind speeds, Gloria was outclassed by a few Caribbean and Gulf of Mexico storms, and certainly by various Pacific Typhoons, but at one point in her life cycle may well have been the most powerful storm on record in the Atlantic Ocean. This would have been during the evening of September 24th and early morning hours of the 25th when reconnaissance aircraft measured the central pressure at 918 millibars or 27.11 inches of mercury. At that time maximum winds within her circulation were in excess of 150 MPH. Fortunately at this point in her travels she was 200 miles to the east of the Bahama Islands such that populated land areas were feeling only peripheral gale winds and high surf. In fact, thus far Gloria had been a very considerate storm, having (jossed) northward to spare the Leeward Islands, the Virgins and Puerto Rico, then continued to curl northwestward while menacing, but not hitting, the Bahama's. In fact, as time would come to prove, the future track and life cycle of "Gloria" would be such as to greatly diminish her effects even in those areas that came under her direct assault; the Mid-atlantic and Northeast Seaboards of the United States. While her effect was significant, particularly in the destruction of trees and therefore power/telephone lines, the sequence of events proved to be such that it is safe to say that this storm affected no populated land areas to the extent that might have been possible under only slightly altered circumstances.

It is somewhat of a paradox that the storm is classified as a "dud" by some, while at the same time it created havoc with power and telephone lines. It is the causes of this apparent paradox and the Gloria life cycle that will be discussed in the following.

How strong a storm was Gloria, and how would it compare with some other great hurricanes that have struck the United States northeastern coastal sections? It is not the intent here to compare, since there are too many other yardsticks of comparison that fall out of the realm of just meteorology. In the final analysis, the overall "ranking" or evaluation of a storm should not be meteorological; rather, it should be how it affected the population, in terms of injuries, deaths, property damage and overall disruption of life. These are the bottom line results, regardless of any scientific autopsy of the storm. For instance, certainly the hurricane of 1938 and Carol in 1954 created a far greater impact than Gloria on the population overall. Yet, in some areas the damage to power lines, in terms of percentage of customers lost, was greater with Gloria than either of the two previous storms. Why would this be true?

Increasing density of population, expansion of electric service and therefore the total miles of lines, simply create more total

targets for one thing. It is suspected that expansion, or explosion, of population into the suburbs since the earlier storms has created an extensive array of power lines in areas that are more heavily treed and without the mutual protection of closely spaced homes, that is the wind break effect. What was once country side, with only a hand full, if any, of customers is now unbroken areas of homes; zoned to have more open space around them and landscaped with individual large trees. Since the dominant factor in power outages will be trees and/or limbs falling on the lines, anything that contributes to tree damage will translate to heavy loss. Furthermore, trees will typically commence to lose limbs at only about 50 mph. Ground conditions play a large factor in healthy whole tree loss, but it would be assumed that single trees will start to fall at no more than about 60-70 MPH. The point being that while the extreme winds of a severe hurricane will commence structural damage, trees will start to fall in a minimal system. Once a tree brings down a power line, it is a bit academic how many others fall on the downed line. Therefore, if power and telephone line loss is to be a ranking factor, then Gloria could be considered a strong to severe storm.

Otherwise, whether Gloria lived up to advance billing depends in large measure on who prepared the billing. The advance hysteria that was promoted by the television media could have been satisfied with little less than the end of the world, and in fact the world's survival seemed to be a matter of disappointment. Despite this overkill in promotion, it must be emphasized that it was true that the area was spared considerably greater impact by a few factors that combined to reduce the overall storm damage pattern. In some respects this will have unfortunate repercussionse, since with these few factors removed in a future storm, Gloria's "cry wolf" may well induce a disastrous indifference in the public when faced with the arrival of a truly severe storm. Specifically, Gloria probably can be classified as a category 1, or marginal 2, on the 5 top end scale. A significant storm, but of minor effect compared to a 4 or 5. But, Gloria was a category 5 when starting its turn toward Long Island so what were these few factors that minimized the total effects?

There is much to be learned about hurricanes and frequently the changes and movements of such storms are not completely understood. Therefore, some of these statements will be conjecture. Essentially there are four factors felt to have contributed to minimizing total damage from this storm.

First, it should be understood that a hurricane is essentially a giant heat engine, drawing energy from the warm ocean waters of its spawning grounds. Typically a water temperature of about 80 degrees Fahrenheit or greater is considered essential to maintaining or increasing strength. Deprived of this warm water, the eye of the storm will tend to spread out, perhaps shifting in the overall storm envelope, attempting to relocate over the warm water. As an eye becomes moth eaten and expands, the energy dissipates and the maximum winds start to diminish. "Strong" winds expand outward in the overall circulation, but "extreme" winds within 40-60 miles of the eye will die off. The Gulf Stream represents the boundary of water sufficient for maintaining eye strength, running northeastward off the southeast U.S. coast, then turning eastward near 38 North Latitude, east of the Chesapeake Bay area. All water in and to the east and south of the Gulf Stream would be sufficiently warm. It is for this reason that all hurricanes that strike the New York/New England area with severe winds must be moving rapidly. It requires a minimum time over the cooler water north of 38N-39N to strike land prior to weakening. Gloria followed a path that took the eye into cooler water just south of Cape Hatteras and then remained over that cooler tongue of cool water, to the east of land and west of the Gulf Stream the remainder of its trip to a land fall over Long Island. As a result the center of the storm began to expand and become ragged in the roughly 12 hours it took to run from Cape Hatteras to Long Island. During that time the central eye pressure rose from 941 millibars (27.79" Hg) just south of Hatteras to 961 millibars (28.38" Hg) over Long Island, or a weakening of some 20 millibars in about 12 hours. While there were other factors that likely played a part in this weakening, it is felt that the critical factor was the duration over this cool water. Thus, the first subtle reason to spare the northeast; since had the center of the storm run northward only about 60 miles further east it would have been over Gulf Stream water and Gulf Eddy water all the way north to 40 Degrees North Latitude, or only 60-100 miles away from densely populated land.

Secondly, prior to the arrival of the storm's primary circulation into the northeast coastal sections, there had been a shallow layer of cool and dry air deposited by an old cold front. This shallow layer persisted even as the storm plunged toward it. Warm and cool air do not like to mix readily, which create the common frontal boundaries. The warm air attempts to ride up over entrenched cooler air. It is felt that this shallow layer of air over the area from Long Island northward into New England tended to loft the stronger, warmer, winds to levels just off the ground. In the attached data sheets there are readings from several meteorological towers situated on Long Island and the Connecticut shore. These show the very strong speed shear that existed from the surface to about 500 feet above ground. This can be seen in the winds for Blue Hill, Massachusetts to some extent, but it should be cautioned that Blue Hill is a monadnock, or singular protrusion and thus tends to have stronger winds by compression of air over its summit. By comparison Blue Hill recorded over 180 MPH in the 1938 hurricane. In any event, it's felt that the highest winds that were associated with the storm tended to stay just off the surface, being felt more over slightly hilly terrain and in random spots where overturning brought narrow "jets" down to the surface. This helps to explain the relatively low sustained winds as compared to peak gusts, and the rather random nature of heaviest damage. This can also be seen in the extreme wind gusts recorded over Cape Cod, specifically the 109 MPH at the Chatham Coast Guard Station, 96 MPH at Falmouth (Otis A.F.B.) and also at Nantucket Island where the cool air was unable to remain entrenched, even though these locations were some

B-5

120-150 miles removed from the center of the storm. Part of the reason for this high a wind away from the center can be attributed to the expanding eye and perhaps also to the third factor to be mentioned below. As regards this particular item however, it should also be remembered that the larger trees will extend 50 to 100 feet off the ground level and thus extend into the shear zones. Also, as with any tropical cyclone, Gloria arrived with the trees in full leaf such that the "sail" effect is maximized.

A third factor in reducing the overall damage potential is a bit less obvious or unknown. Through the last 24 hours or so of the storm's track northward, reconnaissance aircraft appeared to be observing a secondary, or concentric, wind maximum. That is, most tropical cyclones have their strongest winds quite near the eye wall, then tail off rapidly in all directions. Gloria seems to have had a secondary "ring" or maximum more than 60 miles away from the eye. This may have dissipated the concentrated energy required for extreme winds at the eye wall and also helped to push the high winds out east and west of the center track, helping to account for those observed winds over Cape Cod.

The fourth factor is not debatable, is quite obvious and merely a matter of fortuitous timings. Gloria tracked northward more or less coinciding with low tide. While severe winds will damage structures and beach boats, it is generally true that the ocean storm surge is what will be the most devastating factor in the total damage pattern of any tropical cyclone. A hurricane builds up an incredible wall of water ahead of it, both by piling it up with wind and literally sucking it up into its low pressure center. Thus, when it arrives at land fall it can bring in a surge of water 20-30 FT above normal, completely destroying many of the coastal structures, bridges, roads, etc. well inland from the normal coast line. Thus, while it is the coastal areas that would expect to receive the catastrophic effects of a strong hurricane, in the case of Gloria this was largely negated by her arrival at low tide, surely preventing an enormous amount of property damage and personal injury or death along the shore line from Long Island to Cape Cod.

Gloria also had a rather peculiar precipitation pattern, again tending to reflect the layer of cool air that it penetrated. The cooler air deepened west and north of the coast, as is usually typical, and as such the extreme rainfall was mainly confined to eastern Pennsylvania and eastern upstate New York, tapering off eastward to virtually no rainfall over Cape Cod. Even in the cyclonic feeder bands that moved into New England the rain fall was sporadic and while briefly heavy, generally did not amount to much in total fall. What factor a heavier rain would have had on tree damage is not known. It would have been heavy and occurring more or less simultaneously with the high winds, so may not have had the opportunity to loosen up the soil sufficiently to greatly enhance tree damage. It may be remembered that soil was saturated and rivers over flood stage WELL AHEAD of the 1938 storm, so that all soil was vulnerable at that time. However, it is suspected that a shift eastward in the rain shield would have at least certainly contributed to greater tree damage. The same 60 mile further east track that might have maintained storm strength would also have moved the rain shield eastward, with obvious combined impact.

The conclusions reached in a preliminary study of hurricane Gloria suggest that there are perhaps three different facets to be considered in assessing damage or severity of any such storm. These would be:

- 1/ Winds of sufficient strength to bring about extensive tree damage, thus causing generally widespread power and telephone communication outages. This strength will generally be sufficient to damage improperly located or anchored boats.
- 2/ Winds of sufficient strength to cause structural damage to buildings, bridges, etc.
- 3/ Winds and storm surge sufficient to cause severe damage to all coastal sections in extreme tides.
- 4/ Perhaps an added category for heavy rain and subsequent potential water damage, but it is felt that while some hurricanes can give extreme rain fall amounts that the "typical" damage pattern associated with hurricanes will be more wind/sea water induced.

With these thoughts in mind, it can be seen that whether a storm is "severe" depends pretty much on the problem each individual is faced with. As such, we would draw these conclusions:

- 1/ Meteorologically, by the time that Gloria arrived near land areas she represented a significant storm, but not particularly severe as hurricanes so, certainly equalled and exceeded by many others before her.
- 2/ Despite #1/ above, Gloria was of sufficient intensity to create extensive tree damage, thus from the standpoint of any interest in that area (power companies, telephone companies, highway maintenance crews, etc.) she was, by their criteria, a "severe" storm.
- 3/ For structural and coastal concerns, the combination of factors that contributed to a substantial diminishing of wind and tides prevented a major catastrophe, and would have to be regarded by those interests as a "mild" storm.

- 4/ It is imperative that it be understood that each hurricane is a separate entity in itself, as the peculiarities of Gloria attest to. In the future the next hurricane to arrive in our vicinity must not be dismissed lightly due to the relative ineffectiveness of Gloria, since that time the factors may cascade positively rather than negatively to bring about a truly catastrophic storm event.

SELECTED HIGHEST HURRICANE GLORIA GUST REPORTS ALONG THE EASTERN SEABOARD (MILES PER HOUR)

NOTE: THE FOLLOWING ARE HIGHEST GUSTS RECORDED AT SPECIFIC POINTS INDICATED, GENERALLY AIRPORT LOCATIONS. THERE HAVE BEEN MANY UNOFFICIAL REPORTS OF HIGHER GUSTS THAN THESE, MADE ON WHAT ARE CONSIDERED TO BE RELIABLE WIND RECORDING INSTRUMENTS, BUT FROM "UNOFFICIAL" LOCATIONS. THIS STORM HAD A SOMEWHAT UNUSUAL WIND GUST PATTERN, PERHAPS TYPICAL OF DECAYING TROPICAL STORMS. SPECIFICALLY, THE SUSTAINED WINDS WERE NOT PARTICULARLY HIGH, AND THE GUSTS CAME IN BURSTS, ALMOST IN THE FORM OF LOCALIZED JETS, SUCH THAT PEAK WIND GUSTS AT ONE LOCATION, OR ALONG ONE SPECIFIC LINE, WERE SIGNIFICANTLY HIGHER THAN A LOCATION OR LINE A SHORT DISTANCE AWAY. THE DAMAGE PATTERN TENDED TO SUPPORT THIS OBSERVATION. IN GENERAL IT CAN BE SAID THAT THE STORM PRODUCED WIND GUSTS IN THE 80-100 MPH RANGE ALONG THE IMMEDIATE COASTAL SECTIONS OF NORTH CAROLINA, VIRGINIA, MARYLAND, DELAWARE AND NEW JERSEY ON NORTHWARD ACROSS LONG ISLAND, NEW YORK, MOST OF THE CONNECTICUT COASTAL SECTIONS AND THEN MOST OF RHODE ISLAND, EASTERN MASSACHUSETTS AND EXTREME SOUTHEASTERN NEW HAMPSHIRE. NORTH AND WEST OF THIS AREA THE MAXIMUM GUSTS WERE LIKELY LIMITED TO LESS THAN 80 MPH. REPORTS OF AS HIGH AS 125 MPH WERE RECEIVED FROM POINTS IN LONG ISLAND, RHODE ISLAND AND EASTERN MASSACHUSETTS. WHILE THESE ARE CONSIDERED SOMEWHAT SUSPECT, THE OVERALL WIND ENVELOPE HISTORY OF THIS STORM SUGGESTS THEY CANNOT BE SUMMARILY DISMISSED. A FURTHER DISCUSSION OF THESE LOCALIZED SEVERE GUSTS WILL BE FOUND IN THE TEXT.

MAXIMUM WIND GUST

NORTH CAROLINA

CAPE HATTERAS: 87 MPH
WILMINGTON: 47 MPH

VIRGINIA

NORFOLK: 67 MPH

MARYLAND

BALTIMORE: 45 MPH

DELAWARE

NO REPORTS AVAILABLE

PENNSYLVANIA

ALLENTOWN: 56 MPH
PHILADELPHIA: 52 MPH

NEW JERSEY

ATLANTIC CITY: 69 MPH
NEWARK: 67 MPH

NEW YORK

ISLIP, L.I.: 84 MPH
LAGUARDIA ARPT: 64 MPH
NEW YORK CITY: 52 MPH
ALBANY: 41 MPH

CONNECTICUT

BRIDGEPORT: 92 MPH
HARTFORD: 82 MPH
NEW HAVEN: 75 MPH
NEW LONDON: 75 MPH
WINDSOR LOCKS: 66 MPH

MASSACHUSETTS

RHODE ISLAND

CHATHAM C.G.:	109 MPH	CASTLE HILL:	83 MPH
BLUE HILL:	100 MPH (629 FT MSL)	PROVIDENCE:	81 MPH
SCITUATE C.G.:	100 MPH	BLOCK ISLAND:	76 MPH
NANTUCKET IS:	96 MPH	WESTERLY:	75 MPH
OTIS A.F.B.:	96 MPH		
CHATHAM NOAA:	81 MPH		
BOSTON:	76 MPH		
SOUTH WEYMOUTH:	71 MPH		
WORCESTER:	71 MPH		
CAPE COD CANAL:	60 MPH		
CHICOPEE:	51 MPH		
SPRINGFIELD:	48 MPH		
NORTH ADAMS:	45 MPH		

NEW HAMPSHIRE

MAINE

MT. WASHINGTON:	127 MPH	PORTLAND:	70 MPH
(6288 FT MSL)			
MANCHESTER:	58 MPH		
CONCORD:	44 MPH		

 METEOROLOGICAL TOWER DATA

BROOKHAVEN, LONG ISLAND, NEW YORK

	MAXIMUM GUST	MAXIMUM SUSTAINED
37 FT LEVEL:	75.9 MPH @11AM	29.1 MPH
290 FT LEVEL:	100.1 MPH @11AM	58.2 MPH

NOTE: 290 FT LEVEL FAILED AFTER 1100 EDT.

MILLSTONE POWER STATION (FOUR MILES WEST OF NEW LONDON, CT)

AT 142 FOOT LEVEL

WINDS GUSTED TO 86 MPH BETWEEN 1250 EDT AND 1255 EDT
 PRIOR TO POWER FAILURE AFTER 1255 EDT.

NORWALK HARBOR POWER STATION

ONE HALF HOUR SUSTAINED WIND OF 25.7 METERS PER SECOND
 (APX 59 MPH) BETWEEN 1145 EDT AND 1215 EDT AT THE
 147 FT LEVEL. NO MAXIMUM WIND AVAILABLE.

SHOREHAM METEOROLOGICAL TOWER (ON NORTH SIDE OF LONG ISLAND, NY)

	MAXIMUM GUST	MAXIMUM SUSTAINED
33 FT LEVEL:	62.0 MPH 12-1 PM	33.2 MPH 11-12 AM
150 FT LEVEL:	69.2 MPH 12-1 PM	42.0 MPH 12-1 PM
400 FT LEVEL:	99.3 MPH 12-1 PM	70.0 MPH 12-1 PM

TABULATED VORTEX CENTER (EYE) POSITIONS FOR TROPICAL CYCLONE "GLORIA"

SIGNIFICANT POSITIONS ARE PRIMARILY AIR FORCE AND NOAA RECONNAISSANCE AIRCRAFT, SUPPLEMENTED WHEN NECESSARY BY LAND BASED RADAR AND STANDARD NATIONAL HURRICANE CENTER BULLETINS.

 ORIGIN OF POSITION: A = AIRCRAFT, R = RADAR, B = NHC BULLETIN

 HEADERS:

TYPE - ORIGIN OF POSITION REPORT

DATE/TIME - DATE AND EASTERN DAYLIGHT TIME OF POSITION REPORT

LAT/LON - LATITUDE AND LONGITUDE OF EYE POSITION; IN DEGREES AND MINUTES FOR RECONNAISSANCE AIRCRAFT AND RADAR WITH DEGREES AND TENTHS OF DEGREES FOR BULLETIN POSITIONS.

C.P. - CENTRAL PRESSURE OF THE EYE, IN MILLIBARS

MAX WIND - MAXIMUM WIND OBSERVED. (NOTE, THIS IS NOT NECESSARILY THE HIGHEST WIND THAT MAY HAVE EXISTED IN THE STORM AT THE GIVEN TIME).

MOVEMENT - DIRECTION STORM IS MOVING TOWARD AND SPEED IN KNOTS.

-- - MISSING ENTRY. OMISSION CAN BE EITHER AT ORIGIN OR WITHIN WSC DATA STORAGE.

 TYPE DATE/ LAT/LON C. P. MAX MOVEMENT
 TIME (MBS) WIND

NOTE: NAMED ATLANTIC TROPICAL DEPRESSION #8

TYPE	DATE/TIME	LAT/LON	C. P. (MBS)	MAX WIND	MOVEMENT
B/	SEPT 17/NOON	14.5N/ 29.5W	1008	30	W-12

NOTE: TROPICAL DEPRESSION #8 UPGRADED TO TROPICAL STORM GLORIA 17/1200 EDT

B/	SEPT 17/MIDNITE	14.8N/ 32.0W	--	35	W-11
B/	SEPT 18/NOON	15.2N/ 38.7W	--	35	W-20
B/	SEPT 18/MIDNITE	15.3N/ 40.5W	--	35	W-18
B/	SEPT 19/NOON	15.5N/ 43.5W	--	35	W-17
B/	SEPT 19/MIDNITE	17.5N/ 45.5W	--	35	WNW-15

SEPT 20/NOON REPORT MISSING

B/	SEPT 20/1800	18.5N/ 50.5W	--	35	--
B/	SEPT 20/MIDNITE	18.5N/ 51.8W	--	35	--
A/	SEPT 21/0817	17 42N/ 54 12W	999	25	--
B/	SEPT 21/NOON	18.0N/ 55.5W	--	45	--

B-11

A/	SEPT 21/1303	17 42N/ 55 12W	1000	65	--
A/	SEPT 21/2000	17 49N/ 56 25W	1000	--	--
B/	SEPT 21/MIDNITE	17.8N/ 57.2W	--	--	--
A/	SEPT 22/0410	17 51N/ 57 05W	997	--	--
A/	SEPT 22/0740	17 44N/ 58 15W	991	50	--
B/	SEPT 22/0900	17.8N/ 58.3W	--	65	

NOTE: TROPICAL STORM UPGRADED TO HURRICANE GLORIA AT
22/0900 EDT

A/	SEPT 22/0941	17 53N/ 58 23W	991	70	--
A/	SEPT 22/1115	18 03N/ 58 28W	992	--	--
B/	SEPT 22/NOON	17.9N/ 59.0W	991	65	W-11
A/	SEPT 22/1410	18 25N/ 58 51W	992	30	--
A/	SEPT 22/1602	18 32N/ 59 13W	989	70	--
A/	SEPT 22/2001	19 03N/ 60 14W	992	--	--
A/	SEPT 22/2206	19 03N/ 60 28W	991	--	--
B/	SEPT 22/MIDNITE	19.2N/ 61.0W	991	65	WNW-11
A/	SEPT 23/0010	19 13N/ 61 02W	990	--	--
A/	SEPT 23/0204	19 31N/ 61 16W	988	--	--
A/	SEPT 23/0405	19 52N/ 61 47W	988	--	--
A/	SEPT 23/0828	20 23N/ 62 59W	988	--	--
A/	SEPT 23/1035	20 36N/ 63 26W	983	--	--
B/	SEPT 23/NOON	21.0N/ 64.0W	983	65	WNW-11
A/	SEPT 23/1323	20 56N/ 64 09W	978	--	--
A/	SEPT 23/2010	21 38N/ 65 42W	986	--	--
A/	SEPT 23/2204	21 44N/ 66 11W	952	--	--
B/	SEPT 23/MIDNITE	22.0N/ 66.5W	952	90	WNW-15
A/	SEPT 24/0103	21 55N/ 66 43W	952	--	--
B/	SEPT 24/NOON	22.9N/ 69.0W	945	100	WNW-15
B/	SEPT 24/MIDNITE	24.5N/ 70.5W	919	130	NW-12

NOTE: LOWEST OBSERVED PRESSURE BY RECON AIRCRAFT WAS 918 MB

B-12

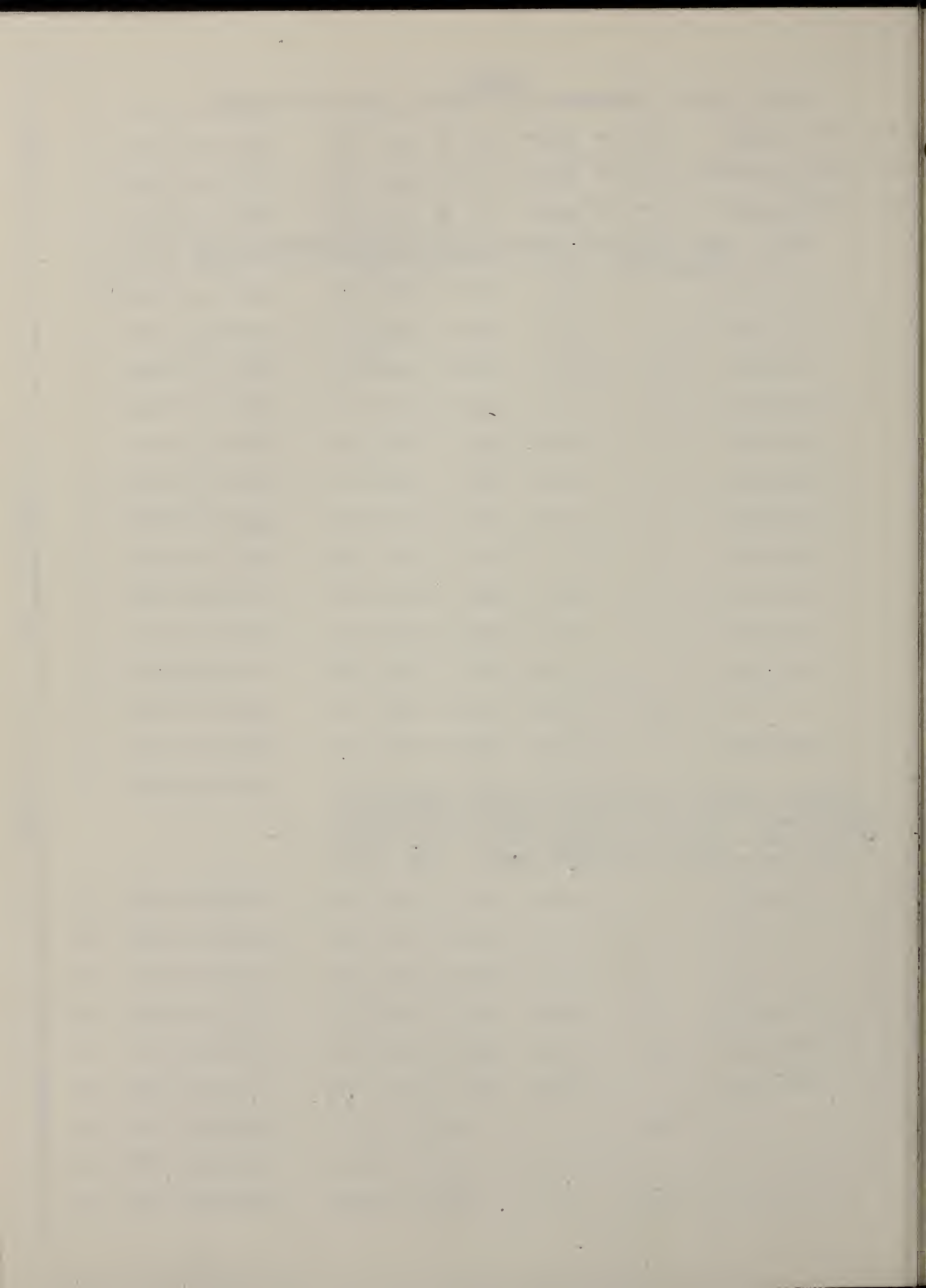
B/	SEPT 25/NOON	26.8N/ 72.8W	929	130	NW-13
A/	SEPT 25/1643	27 20N/ 73 22W	936	125	NW-13
A/	SEPT 25/1910	27 42N/ 73 57W	938	--	--/16.9
A/	SEPT 25/2205	28 03N/ 74 26W	939	--	--/12.3
A/	SEPT 26/0144	28 33N/ 74 52W	942	--	--/7.1
A/	SEPT 26/0449	29 07N/ 75 06W	945	--	340/11.9
A/	SEPT 26/0740	29 58N/ 75 25W	947	--	342/18.8
A/	SEPT 26/1100	30.43N/ 75 57W	945	--	330/15.9
A/	SEPT 26/1235	31 03N/ 76 05W	--	--	342/13.4
A/	SEPT 26/1335	31 22N/ 76 10W	946	--	347/19.5
A/	SEPT 26/1448	31 42N/ 76 12W	944	--	355/16.5
A/	SEPT 26/1553	32 01N/ 76 15W	--	--	353/17.7
A/	SEPT 26/1633	32 11N/ 76 14W	--	--	001/15.0
A/	SEPT 26/1714	32 23N/ 76 13W	943	--	001/17.6
A/	SEPT 26/2017	33 18N/ 76 04W	941	--	008/18.2
A/	SEPT 26/2137	33 43N/ 75 55W	941	--	018/19.6
A/	SEPT 26/2258	34 16N/ 75 51W	941	100	--
A/	SEPT 27/0009	34 46N/ 75 46W	941	--	002/25.6
*	SEPT 27/0131	35 16N/ 75 16W	EYE PASSES DIRECTLY OVER CAPE HATTERAS WEATHER OBSERVATION POINT (35 16N/ 75 16W). PEAK WINDS NORTH SIDE OF EYE RECORDED AS 81 MPH; SOUTH SIDE AS 82 MPH. LOWEST PRESSURE RECORDED 947.5 MB.		
A/	SEPT 27/0140	35 26N/ 75 37W	942	--	010/26.8
R/	SEPT 27/0230	35 37N/ 75 18W	--	--	--
R/	SEPT 27/0330	36 02N/ 75 05W	--	--	--
A/	SEPT 27/0609	37 35N/ 74 58W	948	--	015/29.6
A/	SEPT 27/0742	38 21N/ 74 32W	951	105	025/32.7
A/	SEPT 27/1012	39 38N/ 73 56W	955	--	020/32.7
B/	SEPT 27/NOON	40.7N/ 73.3W	--	105	--
B/	SEPT 27/1400	41.9N/ 72.7W	--	--	--
B/	SEPT 27/1800	43.5N/ 71.5W	--	--	--

B-13

NOTE: GLORIA DOWNGRADED TO TROPICAL STORM 27/1800 EDT

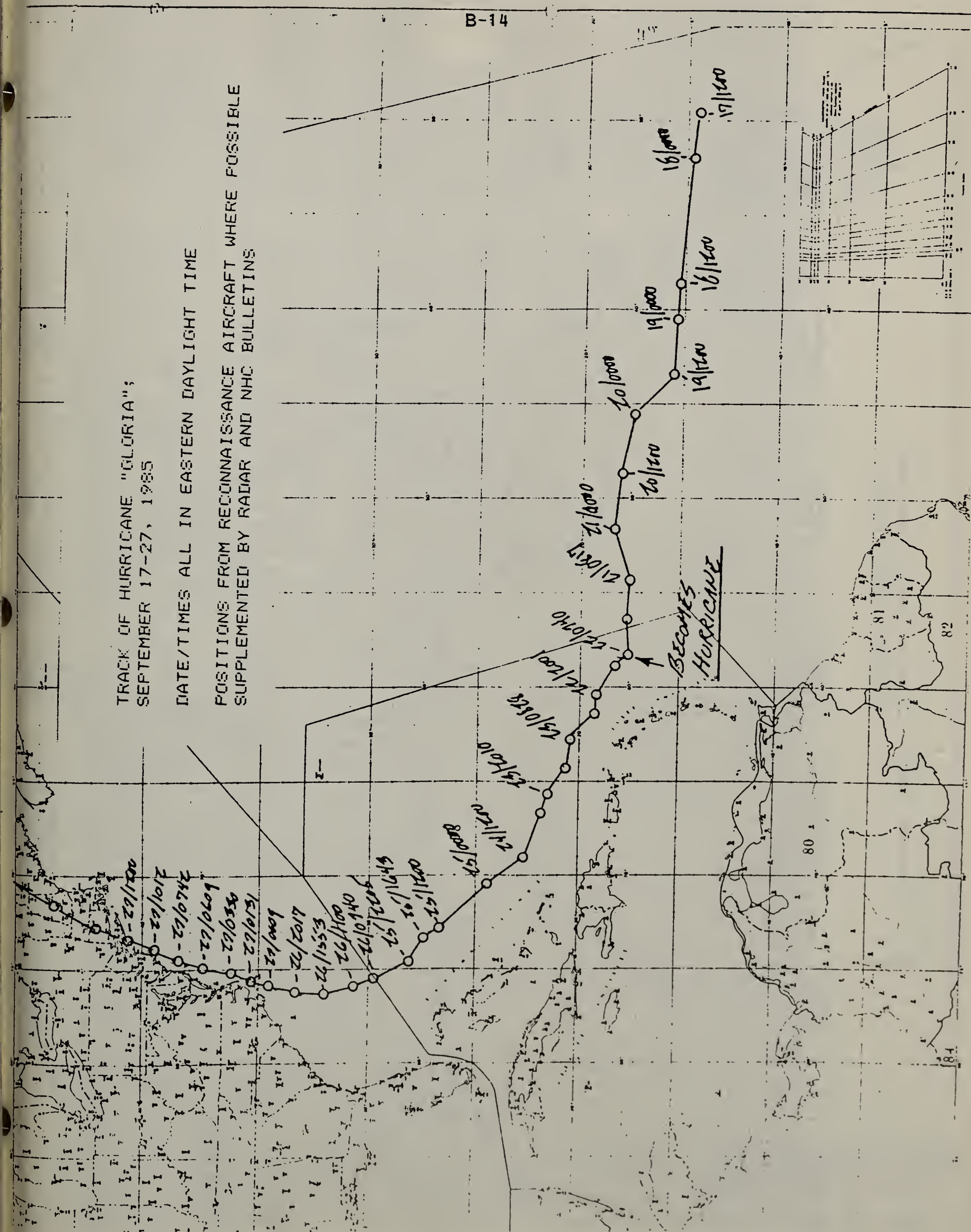
B/	SEPT 27/2200	45.5N/ 69.8W	--	--	--
B/	SEPT 27/MIDNITE	46.5N/ 69.0W	--	--	--
B/	SEPT 28/0600	49.0N/ 66.0W	--	--	--

NOTE: LAST BULLETIN, STORM BECOMES EXTRA-TROPICAL AS OF
28/0600 EDT

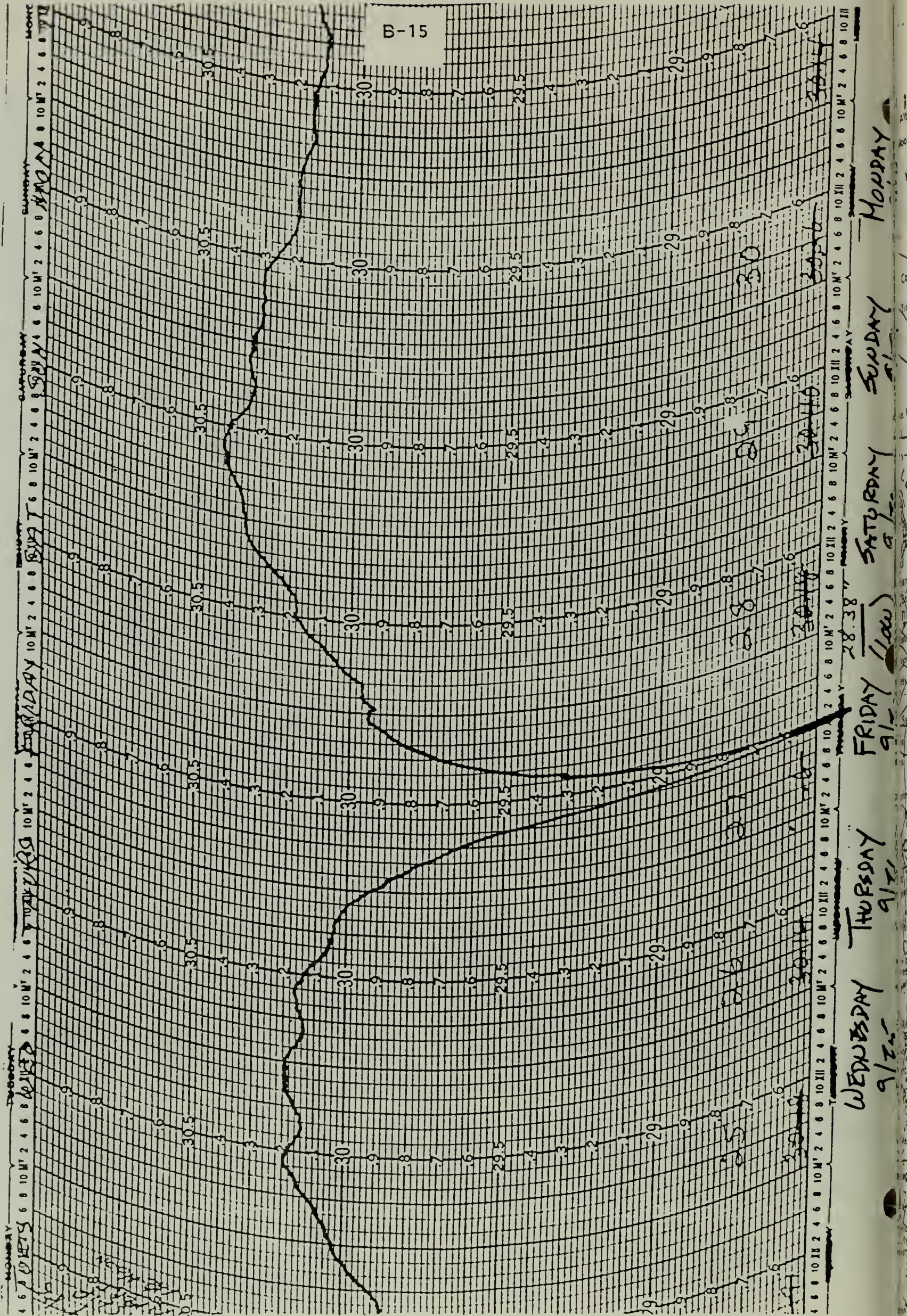


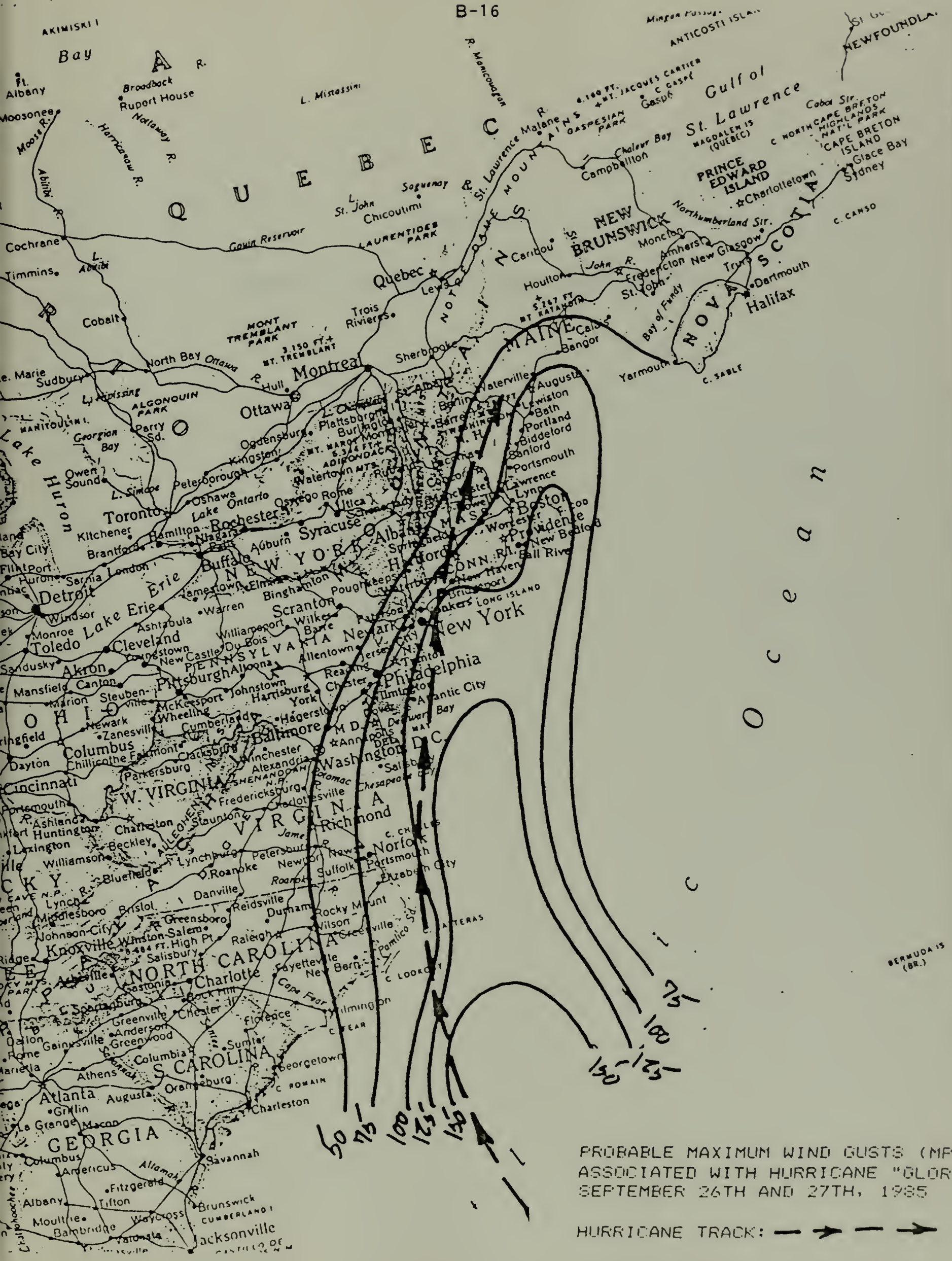
DATE/TIMES ALL IN EASTERN DAYLIGHT TIME

POSITIONS FROM RECONNAISSANCE AIRCRAFT WHERE POSSIBLE
SUPPLEMENTED BY RADAR AND NHC BULLETINS



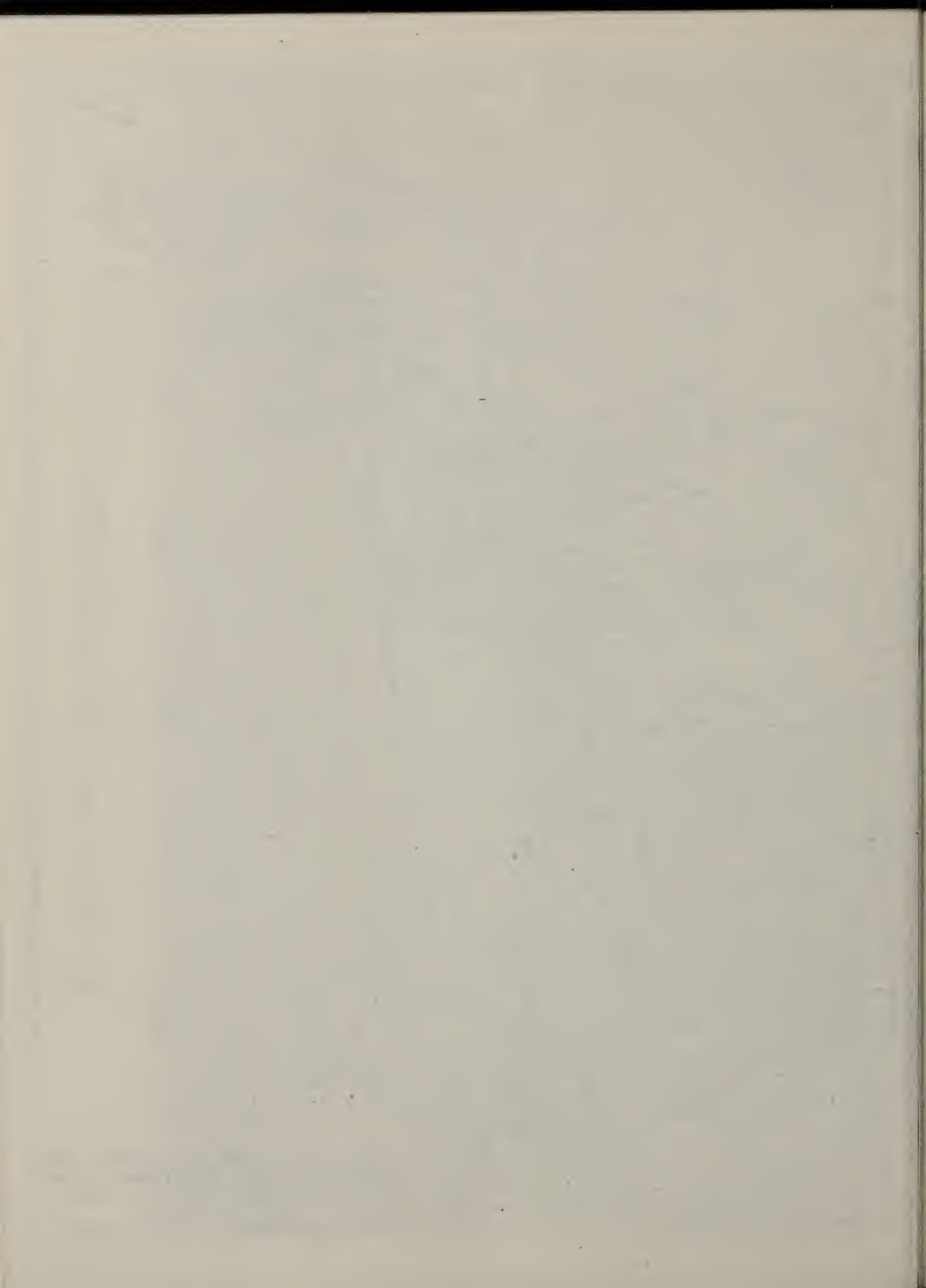
BAROGRAPH TRACE: FROM MELVILLE, NEW YORK
(CENTRAL LONG ISLAND)





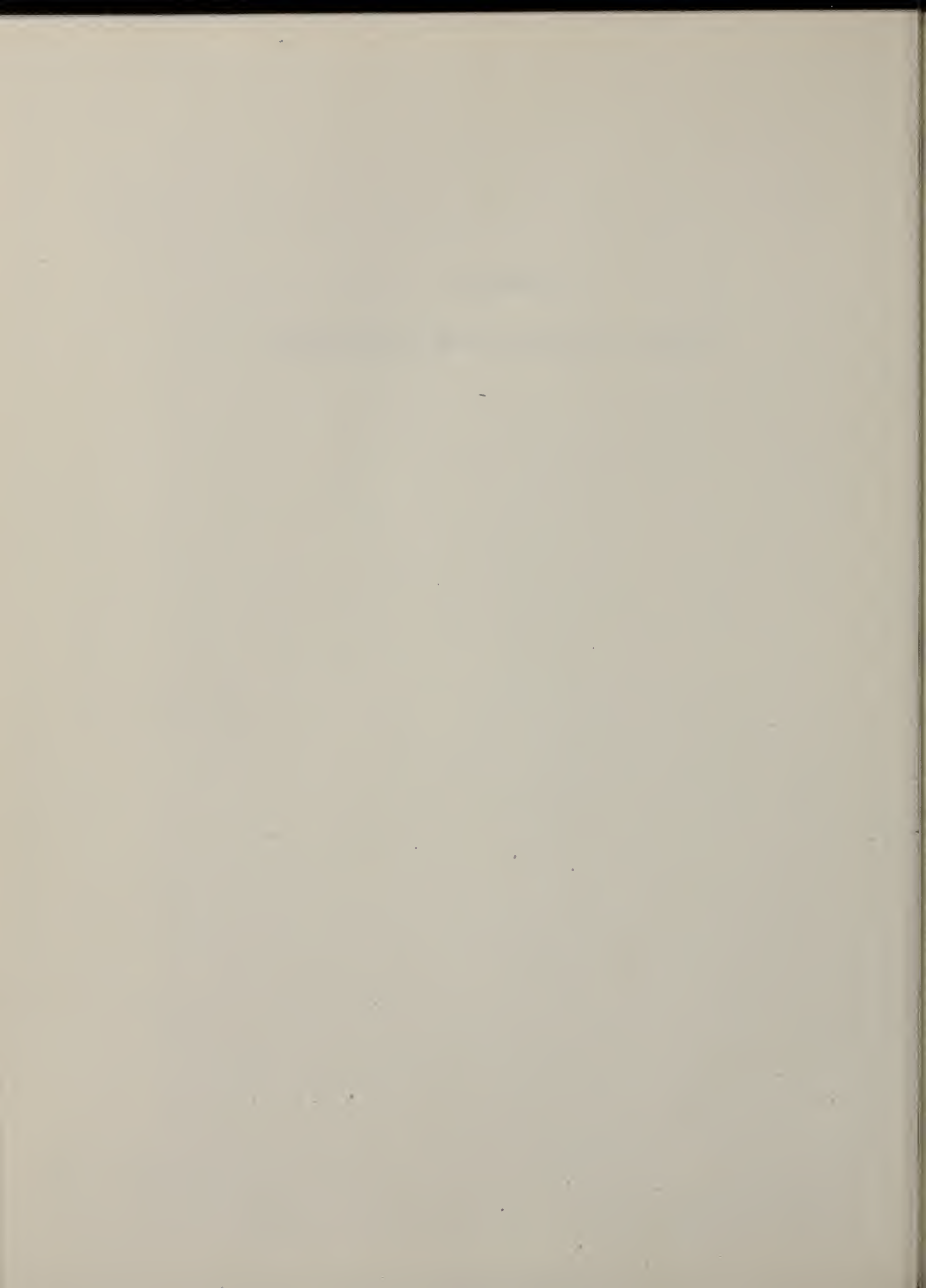
PROBABLE MAXIMUM WIND GUSTS (MPH)
ASSOCIATED WITH HURRICANE "GLORIA"
SEPTEMBER 26TH AND 27TH, 1935

HURRICANE TRACK: — — — — —



APPENDIX C

Inventory of Historical Storms in Massachusetts



August 15, 1635	Water level rose 20'	A hurricane, it was described by William Bradford as the first recorded storm in New England. It coincided with the perigeon spring tide.
February 24, 1722	Water level rose 15'4' water	The storm was a northeaster.
January 1, 1778		It was called the "Magee Storm" and had the highest tide reported in fifty years. The storm's rising water pushed ice floes into the marshes and destroyed the marsh hay stack structures.
April 17, 1851	Water level was 14'9' above mean low water	Called "Minot's Gale", it produced extensive coastal flooding. In Sandwich, the tide waters reached the Glass Works.
April 12-24, 1888		The "Blizzard of 88" was a northeaster with extremely high winds.
November 26, 1898	The water level rose 14' above mean low water	The "Portland Gale" was the most destructive storm in the history of Sandwich. Its 60-80mph winds pushed a wall of water four feet high over the marshes and destroyed parts of the dike and railroad bed. Main and River Streets in Sandwich were flooded. The passenger ship The Portland was lost off the coast of Cape Cod.
December 26, 1909	At Barnstable, the water rose 5' above mean low water	The storm was a northeaster.
March 3-4, 1927		A perigeon spring tide, it coincided with onshore winds of 21-49 mph.

September, 1938	The water level rose 5' above mean high water	This devastating hurricane took 187 lives and caused record flooding throughout New England.
December 29, 1939		Gales from a storm center at sea produced a tide surge which happened to coincide with one of the highest normal spring tides of the year. This caused the flooding of waterfront streets in Boston, a high tide 16' above msl in Chelsea and beach erosion. 1500 people were forced to leave their homes.
April 21, 1940	The water level rose 13'8" above mean high water	This storm combined 31 hours of 30+ mph winds with a perigean spring tide.
Sept. 14-15, 1944		This hurricane had 80-104 mph winds.
Nov. 28,30, 1945	The water level rose 12'5" above mean low water	This storm, like the storm of April 21, 1940, has sustained onshore winds with a perigean spring tide. There was much damage to shorefront property and erosion of as much as 15'.
August 31, 1954		Hurricane Carol's 100 + mph winds caused much damage to the south shore.
September 11, 1954		Hurricane Edna, closely following Carol, had winds of 100 + mph and caused additional damage to the South Shore.
December 29, 1959	The water level rose 15' above mean low tide and in Boston	This storm had gale force winds. Tidal flood waters engulfed all coastal areas, battering sea walls and causing flooding to within 50 yards of Main Street in Barnstable. 13 houses were inundated there.

Sept. 12-13, 1960

Hurricane Donna

November 28, 1967

This storm was another example of a perigean spring tide coinciding with sustained onshore winds.

Feb. 19-20, 1972

This storm developed in New England, moved northeastward over Cape Cod into the Gulf of Maine. Devastation along the coast north of Plymouth was greatest. Coastal flooding in Essex, Ma. was reported as being the most severe in town history. Several coastal communities were declared disaster areas by the President.

January 8-9, 1978

This storm occurred on a higher than normal tide and caused flooding and severe coastal erosion.

February 6-7, 1978

The "Blizzard of 78" was a northeaster with record snowfall, flooding and erosion. An estimated total of 180 million dollars of damage in the most destructive storm of recent times.

APPENDIX D

Earthquake History of Massachusetts

EARTHQUAKE HISTORY of MASSACHUSETTS

By Carl Van Hake

Massachusetts was the sixth state of the original thirteen to enter the Union (1788). However, the region was visited by English explorers as early as 1602, followed by the arrival of the Pilgrims at Plymouth in 1620. The early settlers compiled the extensive historical accounts that are now available. Nineteen earthquakes, intensity V or greater, have centered in Massachusetts. A number of other earthquakes were centered off the coast of Massachusetts and affected the eastern portion of the state. A shock in 1755 reached intensity VIII at Boston and was felt across the state. In addition, Massachusetts was affected by some of the more severe Canadian shocks plus the earthquake of 1929 that centered on Grand Banks of Newfoundland. A seismic risk zone of 3 covers the area around Boston as a consequence of the 1755 earthquake and many other lesser earthquakes in the area. Most of the state is

included in zone 2, with the southwestern portion in zone 1.

Strong earthquakes in the St. Lawrence Valley in 1638, 1661, 1663, and 1732 were felt in Massachusetts. The 1638 and 1663 shocks damaged chimneys at Plymouth, Salem, and Lynn. On June 11, 1643, Newbury, Mass., was strongly shaken. Again in 1727 (November 9) an earthquake described as "tremendous" in one report and "violent" in another caused much damage at Newbury. The shock was felt from the Kennebec to the Delaware River and from ships at sea to the extreme western settlements. Several strong aftershocks were reported from the area through February 1728.

Eastern Massachusetts was shaken moderately on February 17, 1737, and June 24, 1741. Then on June 14, 1744, large numbers of bricks were shaken from tops of chimneys at Boston and other towns and stone walls were shaken down. Many persons in Newbury and Ipswich were alarmed. The earthquake was reported felt severely at Falmouth, Maine.

On November 18, 1755, one of the most significant earthquakes in the northeastern region occurred off Cape Ann. At Boston walls and chimneys were thrown down and stone fences were knocked down (intensity VIII, modified Mercalli

scale). Some descriptions mentioned violent movement of the ground, like waves of the sea, making it necessary to cling to something to prevent being thrown to the ground. At Pembroke and Scituate small chasms opened in the earth through which fine sand reached the surface. Large numbers of fish were killed and many people on vessels felt shocks as if the ships were striking bottom. This earthquake was felt from Lake George, N.Y., to a point at sea 200 miles east of Cape Ann, and from Chesapeake Bay to the Annapolis River, Nova Scotia, about 300,000 square miles. Reports of a seismic sea wave reaching the West Indies following the earthquake appear to be erroneous. A tsunami had occurred in the West Indies on November 1, 1755, following the great Lisbon-earthquake, which apparently led to a report of its association with the Cape Ann earthquake.

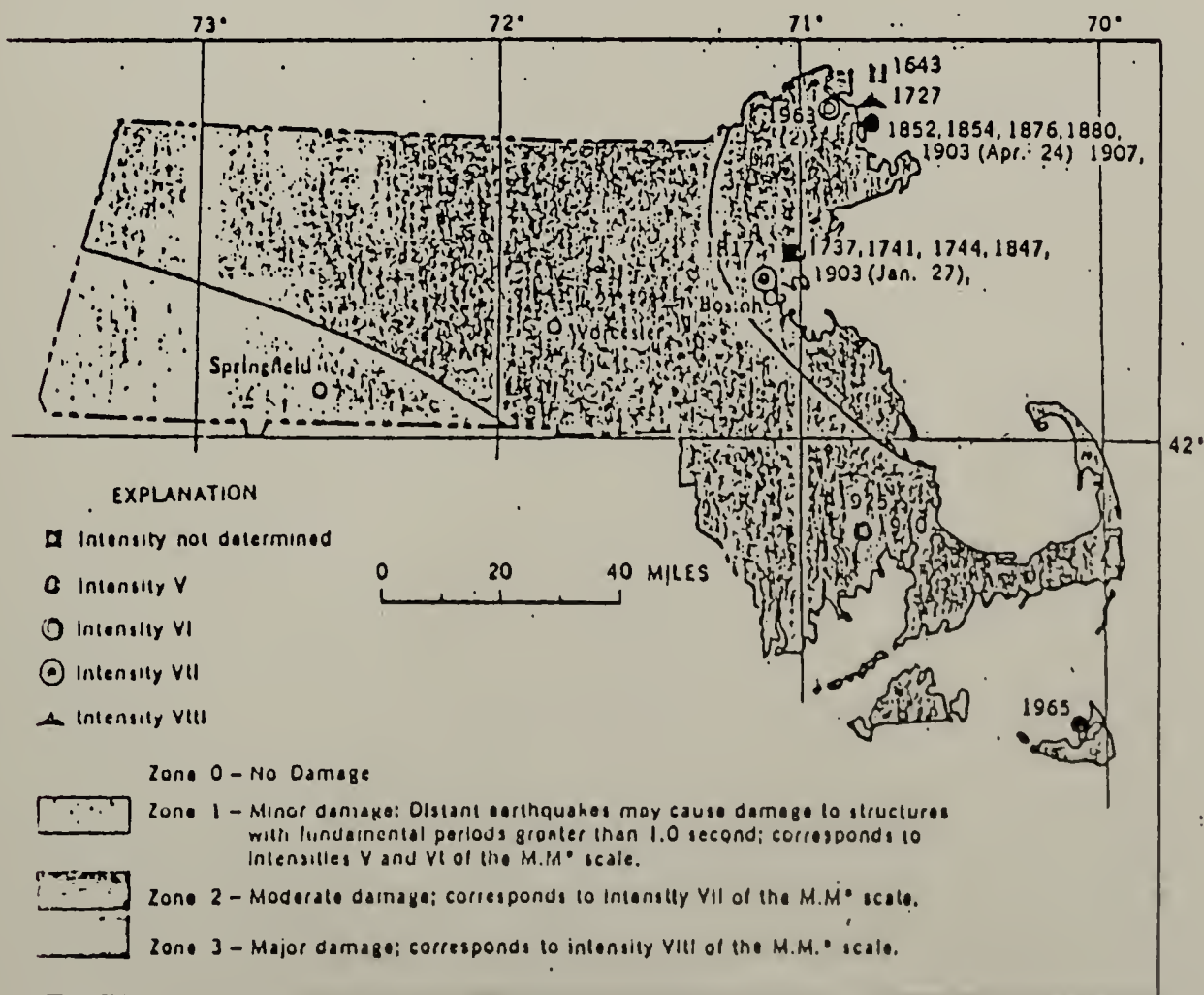
Little information is known about an earthquake that occurred on October 5, 1817. Walls were reported thrown down at Woburn (VII-VIII), but additional details are lacking.

Moderate earthquakes in 1847 (August 8), 1852 (November 27), 1854 (December 10), 1876 (September 21), 1880 (May 12), 1903 (January 21 and April 24), 1907 (October 15), 1925 (January 7

and April 24), 1940 (January 28), and 1963 (October 16 and 30), were felt over limited areas of eastern Massachusetts. The epicenter of the January 7, 1925, shock was off Cape Ann; the reported felt area extended from Providence, Rhode Island, to Kennebunk, Maine. The October 16, 1963, shock, measured at magnitude 4.5 on the richter scale, caused some plaster to fall at Somerville; in addition a wall was reported cracked and stones fell from a building foundation (intensity VI). Dishes were broken and many persons were alarmed at

Amesbury, and a window was cracked at Winthrop. The other earthquakes did not exceed intensity V.

The residents of Nantucket Island were jolted by a moderate earthquake on October 24, 1965. Very slight damage, mostly to ornaments, was reported. Doors, windows, and dishes rattled, and house timbers creaked. Since that date, a number of slight shocks have been felt in Massachusetts from sources outside the state, but none of these caused any damage.



APPENDIX E

Federal Emergency Management Agency Disbursement Summary Report,
October 1986.

FEDERAL EMERGENCY MANAGEMENT AGENCY

DMIS REPORT 2.6 DISBURSMENT SUMMARY BY CONTRACT
CONTRACT(S): 325,357,405,546,650,731,3059

<u>CONTRACT</u>	<u>REG</u>	<u>ST</u>	<u>ADVANCED</u>	<u>RECOUPED</u>	<u>PAID</u>	<u>RETURNED TO PR FND</u>	<u>LIQUIDATED</u>
Severe Storms & Flooding							
325	01	MA	1,174,200.00	1,174,200.00	5,566,726.75	982,941.39	7,723,868.14
Toxic algae							
357	01	MA	136,129.00	136,129.00	.00	63,871.00	200,000.00
City of Chelsea							
405	01	MA	495,751.00	495,751.00	1,022,137.24	124,769.23	1,642,657.47
Blizzard '78							
546	01	MA	24,102,943.63	24,102,943.63	12,644,952.97	3,822,527.74	40,570,424.34
City of Lynn							
650	01	MA	2,019,010.78	2,019,010.78	252,155.09	595,500.78	2,866,666.65
Gloria							
751	01	MA	11,364,746.00	.00	1,024,103.69	248,878.00	1,272,981.69
Storm of '78							
3059	01	MA	2,060,372.00	2,060,372.00	16,887,402.49	63,104.59	19,010,879.08
7 CONTRACTS			41,353,152.41	29,988,406.41	37,397,478.23	5,901,592.73	73,287,477.37

APPENDIX F

A report on the Assessment of Flood Damage Resulting from the Storm of 6-7 February 1978 Along the Coastline from Orleans, Massachusetts to New Castle, New Hampshire. New England Division, Corps of Engineers.

A REPORT
ON
THE ASSESSMENT OF FLOOD DAMAGES
RESULTING FROM THE STORM
OF 6-7 FEBRUARY 1978
ALONG THE COASTLINE
FROM
ORLEANS, MASSACHUSETTS TO NEW CASTLE, NEW HAMPSHIRE

New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

FEBRUARY 1979

IX. Summary of Findings

In the aftermath of devastating coastal storm of February 6, 7, 1978 there became apparent that a need existed for an in-depth evaluation of the storm's effect upon the coastline. As a means of documenting these effects the New England Division approached the states of Massachusetts and New Hampshire with a proposal. The intent was to re-direct funds, previously earmarked for water supply studies through Section 22 authority (Planning Assistance to States), into a study to document the impact of the storm on the coastal communities of the two states. We stressed the importance of gathering and recording data "while the trail was still fresh." Both states readily complied with our requests, and some \$55,000 was committed to this study in July 1978.

The study consisted of two major work items; the first documented costs and losses by community, nature of loss, both direct and indirect; and, the second was an aerial photographic effort to acquire low level, large scale color imagery of the affected coastal reaches of the communities which had sustained major damage.

The "Blizzard of '78", caused nearly \$300 million in flood and wind damage in the 46 coastal communities from Orleans, Massachusetts to New Castle, New Hampshire. This estimate included losses to man-made and natural features and incorporates damages to both public and private property.

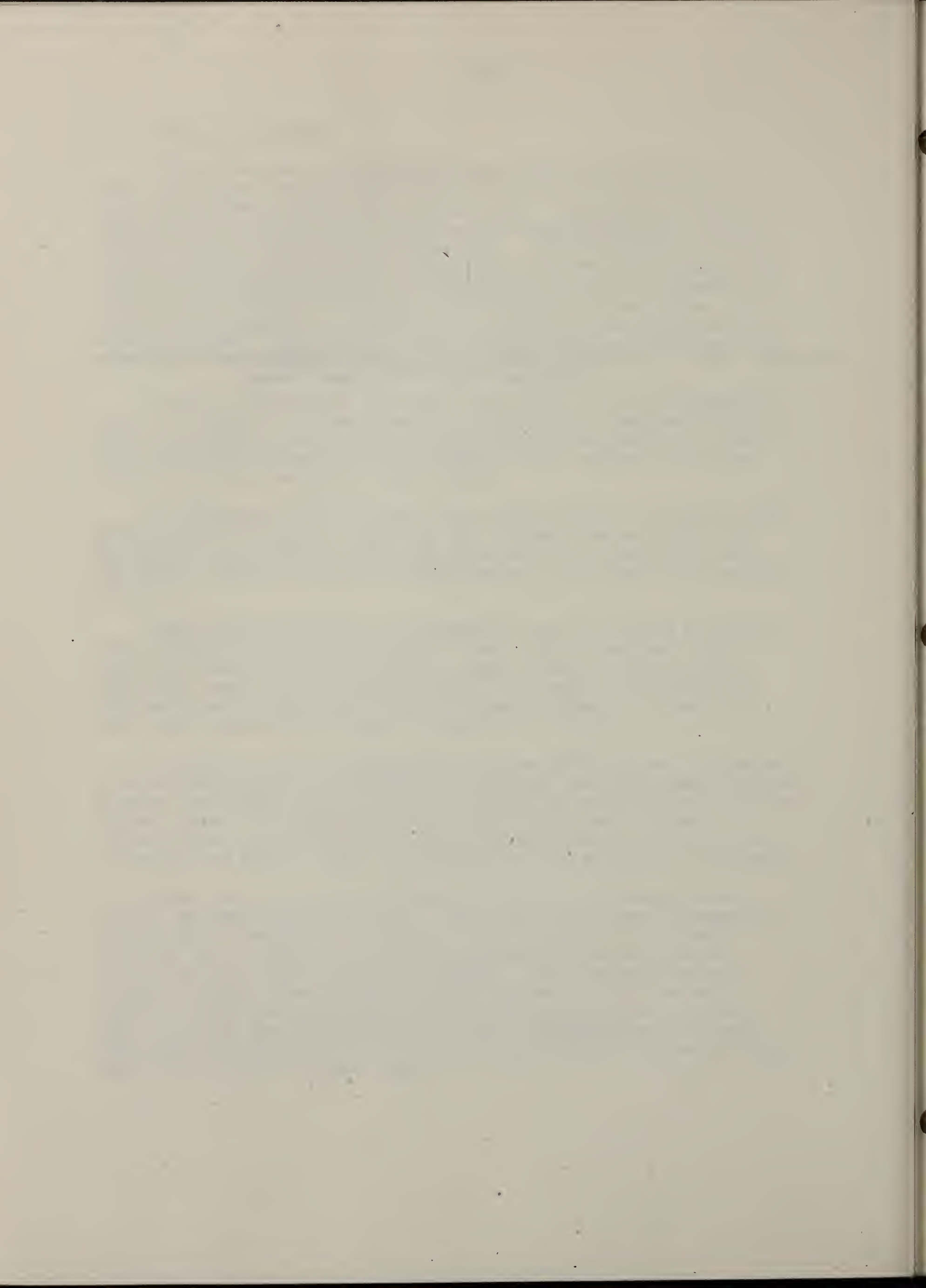
Several meteorological and astronomical events combined to produce this intense and devastating storm. A warm, moist, low level, low pressure system from the mid-Atlantic Ocean combined with an intense, high level, very cold, low pressure mass from Canada. The result of this match was a storm with a return frequency close to 100 years and with storm induced tidal surges in excess of 3.4 feet.

The damage in the 46 communities included \$250 million in Massachusetts and \$10 million in New Hampshire with the remaining damage occurring in other communities outside of the 46 studied or unable to split between the two states. Of this damage, almost 80 percent was attributed to property loss both private and public; indirect expenses, such as clean-up, rescue and shelter costs, contributed to the remainder of the damage.

Almost half of the total damage occurred in seven Massachusetts and two New Hampshire communities. The seven Massachusetts communities which were the hardest hit economically were Plymouth, Marshfield, Scituate, Hull, Revere, Lynn, and Gloucester; the two New Hampshire communities were North Hampton and Hampton. These communities are located in areas where the shoreline was perpendicular to the wave approach and/or the development was close to the shoreline. In many cases, the only protection offered to these developed areas were man-made protection devices rather than the natural barrier beaches and sand dunes which existed in other areas.

Appendix G

780 CMR: State Building Code, Section 744.0. Design Requirements for Flood-
plains and Coastal High Hazard Areas.



780 CMR: STATE BUILDING CODE COMMISSION

SECTION 744.0 DESIGN REQUIREMENTS FOR FLOODPLAINS
AND COASTAL HIGH HAZARD AREAS

744.1 Designated areas and projects: Plans for all structures and gas storage tanks, including new construction and substantial improvements to existing structures, and the placement of manufactured buildings and mobile homes, shall be subject to review by the building official to determine if the location is within any area of special flood hazards as designated by the Federal Insurance Administration (FIA), through issuance of a Flood Hazard Boundary Map or through a scientific and engineering report entitled "Flood Insurance Study" with accompanying Flood Insurance Rate Maps and Flood Boundary and Floodway Maps.

For the purposes of this section only, substantial improvements shall be defined as any repairs, reconstruction, or improvements, the cost of which exceeds fifty (50) per cent of the market value of the structure before repairs or damages.

744.2 Structural requirements in floodplains: If a structure is to be constructed, or substantially improved within the one hundred (100) year floodplain (land subject to a one (1) per cent or greater chance of flooding in any given year), as determined by the building official, it shall be designed and constructed to minimize flood damage. Plans for such building shall be submitted and certified by a registered professional engineer or architect to insure that the following requirements are met:

1. The building is designed (or modified) and adequately anchored to prevent flotation, collapse or lateral movement.
2. The building is constructed with materials and utility equipment resistant to flood damage.
3. Residential structures shall have the lowest floor, including basement or cellar, elevated to or above the one hundred (100) year elevation; or in the case of nonresidential structures, be floodproofed watertight to the one hundred (100) year level.
4. Where floodproofing is allowed for a particular building, it shall be designed to be watertight below the one hundred (100) year flood level and the floodproofing methods shall be adequate to withstand the flood depths, pressures, velocities, impact and uplift forces and other factors associated with the one hundred (100) year flood.
5. All mobile homes be anchored to resist flotation collapse, or lateral movement by providing over-the-top and frame ties to ground anchors in the following manner:
 - a. over-the-top ties be provided at each of the four corners of the mobile home; with two (2) additional ties per side at intermediate locations for mobile homes greater or equal to fifty (50)

780 CMR: STATE BUILDING CODE COMMISSION

feet long, and one (1) additional tie per side for mobile homes less than fifty (50) feet long;

- b. frame ties be provided at each corner of the mobile home; with five (5) additional ties per side at immediate points for mobile homes greater or equal to fifty (50) feet long, and four (4) additional ties per side for mobile homes less than fifty (50) feet long;
- c. all components of the anchoring system be capable of carrying a force of four thousand eight hundred (4,800) pounds; and
- d. any additions to the mobile home be similarly anchored.

744.3 Structural requirements in coastal high hazard areas: If a structure is to be constructed or substantially improved within a coastal high hazard area (land subject to high velocity waters, including hurricane wave wash), as determined by the building official, plans for such building shall be submitted and certified by a registered professional engineer or architect to insure that the following requirements are met:

- 1. the structure is elevated on adequately anchored pilings or columns, and securely anchored to such piles or columns so that the lowest portion of the structural members of the lowest floor (excluding the pilings or columns) is elevated to or above the one hundred (100) year level;
- 2. the structure is securely anchored, as provided above, in order to withstand velocity waters and hurricane wave wash;
- 3. fill is not used for structural support; and
- 4. the space below the lowest floor free is of obstructions or constructed with breakaway walls intended to collapse under stress, such temporarily enclosed space not to be used for human habitation.

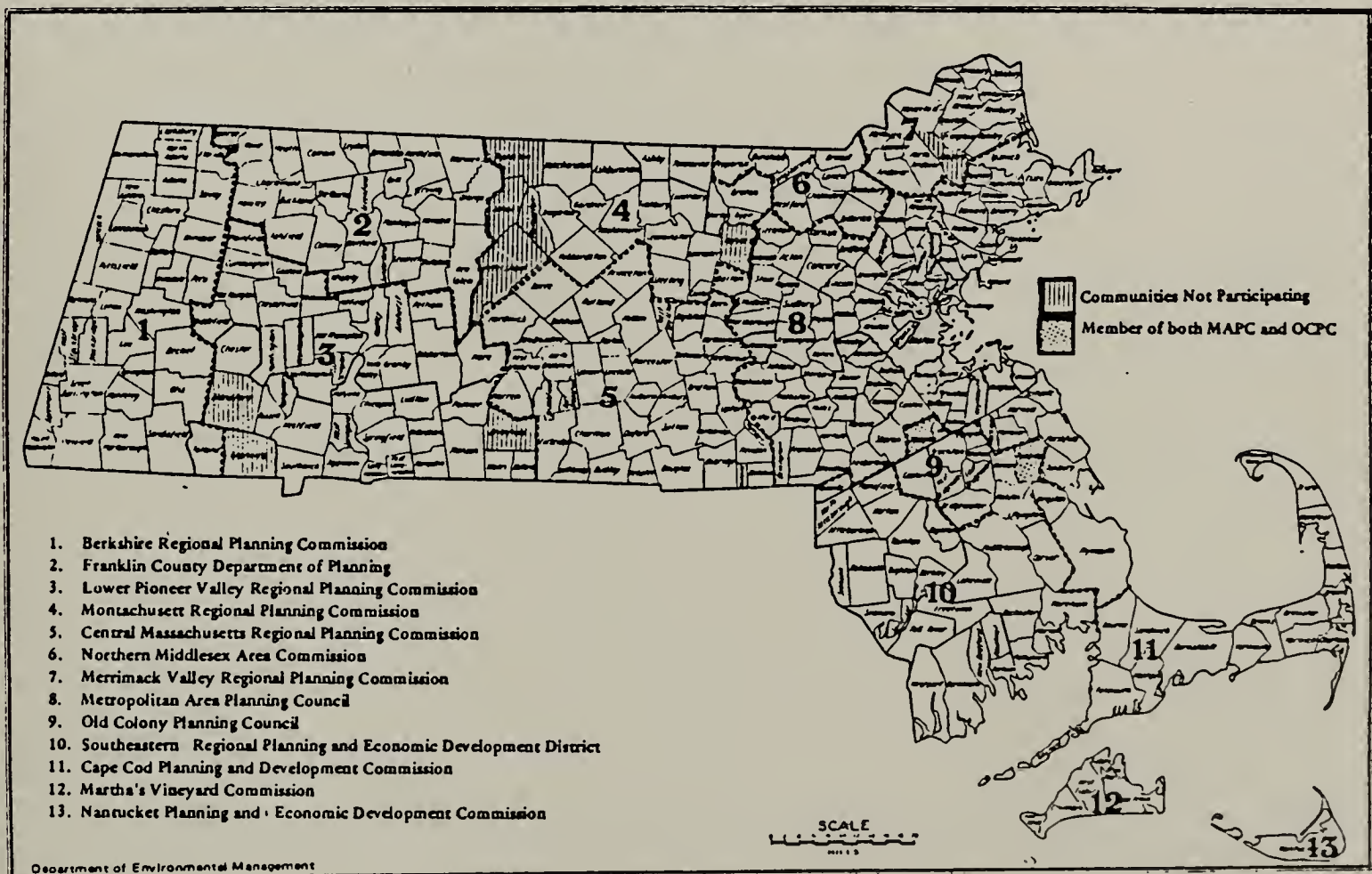
744.4 Records: The building official shall obtain (or have the applicant provide) and maintain for public inspection a record of:

- 1. the elevations, in relation to mean sea level, of the lowest floor, including basement or cellar, and whether or not the building has a basement or cellar;
- 2. the elevation, in relation to mean sea level, to which a building has been floodproofed; and
- 3. the date when such construction commenced.

APPENDIX H

Boundaries of Massachusetts Regional Planning Agencies

THE COMMONWEALTH OF MASSACHUSETTS
Regional Planning Districts



APPENDIX I

Commonwealth of Massachusetts Natural Hazard Mitigation Questionnaire

Commonwealth of Massachusetts
Natural Hazard Mitigation Questionnaire

The purpose of this questionnaire is to assist in the review of Massachusetts' natural hazard mitigation procedures. This questionnaire has been developed pursuant to the Federal-State Disaster Assistance Agreement signed by the Governor following hurricane Gloria.

Please return this completed questionnaire by Friday, April 4, 1986 to:

Michael Beshara
Hazard Mitigation Coordinator
Division of Water Resources
100 Cambridge Street
Boston, Massachusetts 02202

Please complete;

Name: _____
Title: _____
Agency: _____
Address: _____
Telephone: _____

Typing is not necessary. For additional comments use the last page.

I. Pre-disaster Planning

1. Please circle any natural disasters your agency has been involved with:

Hurricane
Flood
Wind
Ice
Tornado
Earthquake
Fire
Snow
Coastal erosion (waves)
Other: _____

2. Please list any Laws, Regulations, Executive Orders, Policies or special Codes that influence or govern your agency's involvement in natural hazard planning.

3. Does your agency have a disaster response plan that mandates procedures which direct divisions, staff, etc? Yes No

Briefly describe the scope of the plan. _____

4. Is the plan written and/or standardized? Yes No

If written please write down full title and plan date. _____

5. Are disaster preparedness procedures actively referred to in agency meetings, memos, etc? Yes No

Briefly explain content. _____

6. Are the policies/activities of the plan carried out?

Yes No

If no, explain, i.e. no funding, low priority, unreasonable expectations.

7. Is the plan or are the mandated procedures, thorough? Do they effectively address disaster needs? Yes No

Discuss improvements needed. _____

8. Does your agency own buildings or improved properties in a flood zone? Yes No

If yes, which of the following precautionary measures are implemented? (circle letters)

- a. turning off utilities
- b. closing gas or water valves
- c. moving valuable equipment/records to higher elevations
- d. boarding up windows
- e. leaving basement windows & doors open to prevent pressure buildup
- f. relocating vehicles
- g. establishing a 24 hour maintenance staff presence at property
- h. additional measures

9. Does your agency construct/fund any structures in flood zones or guarantee loans or grants for construction in flood zones? Yes No

If yes, list considerations used when building is in a flood zone.

10. Are practice drills conducted? Yes No

II. Responding to the Natural Disaster Emergency

1. As a natural disaster emergency develops, what communications systems (i.e. phone, portable radios, vehicles with radios, etc) does your agency have available? List.

2. What other organizations or levels of government does your agency coordinate or communicate with relative to natural disaster management?
 Please list agency & activity involved. _____

3. Briefly describe any problems in coordination between federal, state, regional and local levels. _____

4. List damage to property (structures, contents, machinery, vehicles, etc.) which could occur at agency's vulnerable properties. _____

5. Briefly describe those duties your agency could no longer perform in the event of a disaster emergency?
 What are the consequences of the agency not functioning? _____

6. Approximately how many commonwealth employees would be prevented from performing their jobs in the event of a disaster emergency?

7. Based on lessons learned from past disasters (1978 Blizzard, 1985 Gloria) list specific examples of steps your agency could take to better prepare for and manage those hazards.

III. Post Disaster Emergency Follow-up

1. If your agency has been impacted by a disaster hazard in the last 15 years was any report or documentation prepared summarizing damages? Is it available for reference? _____

2. Does your agency have funds available for floodproofing?
Yes No

3. Is your agency currently working on a disaster/hazard mitigation plan?
Yes No

Anticipated date of completion _____

IV. Recommendations

Use the remaining space to include general observations/problems which were not addressed in the questionnaire. A list of problem areas is suggested.

- a. preparedness planning:
- b. public notification/municipal outreach:
- c. dam safety:
- d. roads and bridges:
- e. channels and culverts:
- f. erosion control:

- g. flood plain zoning:
- h. public utilities:
- i. temporary housing/emergency shelters:
- j. medical, food and water supplies, and emergency equipment:
- k. insurance claims:
- l. debris removal:
- m. revegetation of disturbed areas:
- n. flood-proofing existing structures:
- o. early warning system:
- p. training of emergency personnel:
- q. practice drills:
- r. availability of information:
- s. coordination
- t. communication:

- u. funding:
- v. emergency operation centers:
- w. acquisition of flood hazard areas:
- x. rescue efforts/evacuation:
- y. operation of flood control structures:
- z. other, please specify:

APPENDIX J

Cover Letter for the Commonwealth of Massachusetts Natural Hazards
Mitigation Questionnaire



The Commonwealth of Massachusetts

Executive Office of Environmental Affairs

100 Cambridge Street

Boston, Massachusetts 02202

MICHAEL S. DUKAKIS
GOVERNOR

JAMES S. HOYTE
SECRETARY

March 11, 1986

Dear Colleague:

On September 27, 1985, Hurricane Gloria swept through the New England Region. In Massachusetts, high winds toppled trees and downed power lines. Flooding occurred in several areas and the coast was battered by large waves. As a result of these damages a Presidential Declaration of Disaster was issued on October 28, 1985. On November 1, 1985, Governor Dukakis signed a FEMA-State Disaster Assistance Agreement which triggered the release of federal dollars to the Commonwealth. Section 10 of the Agreement states that the Commonwealth will prepare a Hazard Mitigation Plan. The purpose of this plan is to identify and evaluate existing hazard mitigation measures which are in place for Federal, State and Local governments within Massachusetts. The goal of the plan is to present recommendations that will improve the efforts of these governmental body's to reduce and/or eliminate future damages that result from natural disasters.

In order for this effort to be comprehensive, I request that you take a few minutes to fill out the enclosed questionnaire. As you do this, please keep in mind any experiences you have had that might relate to any type of natural disaster that has occurred in Massachusetts such as; hurricanes, the Blizzard of 1978, fires, floods, etc. Please return the questionnaire within two weeks so that we can compile the information in a timely fashion.

Sincerely,

A handwritten signature in cursive script that reads "Michael L. Beshara".

Michael L. Beshara
Hazard Mitigation Officer

MLB/JB:sla
Enclosure

